Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the third issue of 1980.

Not only did David Dunham author most of the material in this issue, he also did most of the proofreading and typing of his articles, in final form for assembly into the camera-ready copy for the printer. The editor extends his thanks.

O.N.'s price is $1/issue, or $4/year (4 issues) including first class surface mailing, and air mail to Mexico. Air mail is extra outside the U.S.A., Canada, and Mexico: $1.20/year in the Americas as far south as Colombia; $1.68/year elsewhere. Back issues also are priced at $1/issue. Please see the masthead for the correct ordering address.

IOTA membership, subscription included, is $7/year for residents of North America (including Mexico) and $9/year for others, to cover costs of overseas air mail. European (excluding Spain and Portugal) and U. K. observers should join IOTA/ES, sending DM 12.-- to Hans J. Bode, Bartold-Knaust Str. 8, 3000 Hannover 91, German Federal Republic. Spanish, Portuguese, and Latin American occultation observers may have free membership in IOTA/LAS, including *Occultation Newsletter en Español*; contact Sr. Francisco Diego Q., Ixpantenco 26-bis, Real de los Reyes, Coyoacán, Mexico, D.F., Mexico.

IOTA NEWS

David W. Dunham

In May, we received a telegram from Guillermo Mallen stating that grazing occultation predictions for the second half of 1980 could not be computed and distributed from Mexico. Consequently, for the last two quarters of 1980, predictions of grazes for Latin American observers in our main IOTA files have been computed and distributed by Joseph Senne. Observers in Spain and Portugal (I-region) should obtain graze predictions from Hans Bode by joining the European section of IOTA, as some have already done. Latin American observers who have not received graze predictions for the second half of this year should write to Senne; it is possible that there are some graze station cards in the IOTA/LAS files which are not in our main IOTA files. If graze predictions for 1981 also can not be computed and distributed from Mexico, which we will assume unless notified otherwise, Latin American observers will have to send $3.50 (only $3.00 for Mexicans) to the main IOTA (Tinley Park, IL) to receive graze predictions for the year. Rather than pay separately for the graze predictions, they may rather simply join the main IOTA, to receive *O.N.* as well. Due to other obligations, Eduardo Przybyl has been delayed in producing *Occultation Newsletter en Español*, so that information about many events is received too late. To help overcome this problem, three regions of IOTA/LAS have been established: Southern South America, directed by Eduardo V. Przybyl, Observatorio Astronomico, Colegio Nacional Luisa R. de Barreiro, 9 de Julio 387, 2300 Rafaela (Santa Fe), Argenina; northern South America, coordinated by Jorge Polman, Clube Estudantil de Astronomia, Colegio Sao Joao, Rua Francisco Lacerda, 455-Varzea, 50.000 Recife - PE - Brazil; Mexico, Caribbean, and Central America, coordinated by IOTA/LAS in Mexico City. The main activity of these regional sections is to produce and distribute notices giving information about events of local interest, such as asteroid occultations and Lunar occultations of planets. Pertinent addresses not given above are in FROM THE PUBLISHER.

Hans Bode suggests that it might be useful, late this year or early in 1981, to have a meeting of IOTA/ES. Anyone interested in this possibility should contact him. In the meantime, the International Union of Amateur Astronomers (IUAA) is planning meetings in Bologna, Italy, 1980 August 28 to 31, and in Brussels, Belgium, 1981 August 3 to 8. More information about these can be obtained from Associazione Astrofili Bolognesi, C.P. 1630 A/D, 40100 Bologna, Italy and from James Doyle, rue de la Neuville, 68 Bte 6, B- 6000 CHARLEROI, Belgium, respectively.

Russell M. Genet, Fairborn Observatory, 1247 Folk Rd., Fairborn, OH 45324, phone 513,879-4583, in conjunction with Dr. Douglas Hall, Dyer Observatory, Vanderbilt University, Nashville, TN 37235, is starting a quarterly newsletter called *International Amateur-Professional Photoelectric Photometry Communication (I.A.P.P.P.C.)*. An annual subscription costs $10.00, while individual issues cost $2.50. An initial (extra) short communication gives a summary of the first IAPPP symposium that was held this June in Fairborn and Dayton, OH, just before the annual Apollo Rendezvous, and states: "Contributions for publication in the *Communications* are solicited in the following areas. (1) Suggested observing programs of current scientific interest to professional astronomers and suitable for amateur photoelectric photometry. (2) Equipment design and construction. (3) Observational and data reduction techniques. (4) Questions from (and answers to questions from) new amateurs. (5) Descriptions of small observatories equipped for photoelectric photometry. (6) Reviews of recent articles, meetings, and equipment relevant to photoelectric photometry." In the design of his own system, Genet has benefited from correspondence with numerous professional and amateur astronomers making photoelectric observations, many of occultations. Occultation observers wanting to get involved (or already involved) in this work can also benefit from IAPPP and their *Communications*. Another symposium is planned for next June. Genet has written an article, "Automated Photoelectric photometry of Variable Stars," which can be obtained by sending him a long self-addressed stamped (only if you live in USA) envelope as long as supplies last. He also published a 7-page article, "A Progress Report on the Development of a Computerized Data Collection System for Astronomical Photoelectric Photometry," in a local computer club newsletter.

The essential equivalent of the detailed U. S. Naval Observatory total occultation predictions can now be computed by Dr. Kyril W. Fabrin, Raadsherrevej 2, Hasseris, 9000 Aalborg, Denmark, telephone (08) 18 15 13. In a one-month test, differences from the USNO predictions generally amounted to 1 to 3 seconds, mainly due to the lack of applying limb corrections (we are trying to overcome this by providing him with a machine-readable copy of Watts' data). I recently sent him a magnetic tape containing input data for occultations for the rest of 1980 for the X, K, and J catalogs, and for 1981 for combined X and K ("X" here also includes planets, minor planets, and galactic-nebular objects, as well as the XZ catalog). It is a tribute to Fabrin's abilities that he was able to convert USNO's complex computer program to use with his university's CDC computer, which is very different from USNO's IBM machine. Of course, European observers who already have detailed predictions from USNO, as is the case for many IOTA/ES members, do not need to have any computed by Fabrin. Procedures for obtaining predictions from Fabrin have not yet been established, but will probably be worked out in the framework of IOTA/ES. In the meantime, transition from the old IBM 360 computer to the IBM 4341 at USNO in April was very easy. The new machine is much faster than the old one, and the USNO predictions for 1981 total occultations have all been computed. Most observers will probably receive their USNO total predictions in August or September. K-catalog stars are included with the X-catalog stars in the 1981 predictions. I will compute and distribute J-catalog predictions for 1981 late this year, to hopefully allow time to make some corrections to the J-catalog.

In previous years, I have collected observations of all non-SAO stars, since nobody else was doing this. However, the HMNAO report forms now have provision for specifying USNO reference numbers, and they are collecting timings of non-SAO X-catalog stars, so for observations made from 1979 onwards, timings of these stars should be reported with the SAO stars rather than to me. For 1981 onward, K-catalog stars can also be reported with SAO timings since, as noted above, they will be included with the USNO XZ predictions. But all J-catalog timings of stars which are neither in X nor K nor SAO nor ZC, and K-catalog timings for only 1980 and previous years, should be sent to me. As noted in a previous issue, HMNAO remains the main collector of occultation timings until a successor is announced by HMNAO. Unfortunately, HMNAO has been very slow (more than a year behind in some cases) in sending residuals of observed timings to observers, which can be especially annoying to new observers who want to see how they are doing. In any case, remember that the timings are still valuable; keep making them when you can!

The calculation of local circumstances of planetary and asteroidal occultations and appulses has now been established as an IOTA service. See the article on upcoming asteroid occultations on p. 104 for details. Jim Carroll in Minnesota is using a copy of my computer program for the calculations.

The automation of Solar eclipse Baily's bead timing reductions is described on p. 102. The prediction of the northern and southern limits of the paths of central (total or annular) eclipses, taking into account the Lunar profile using Watts' limb correction data, has also been automated. The program was verified by comparing with my manual calculations for last February's total eclipse in India, and was then used to calculate the limits of the annular eclipse across South America on 1980 August 10. Manuel de la Torre, Astronomy Department, Bolivia University, La Paz, had written requesting general predictions of the eclipse. I sent him a package of detailed path predictions, urging that observations be made of Baily's bead events at locations near both limits, to assess the utility of annular eclipses for Solar radius measurements. Unfortunately, the day after the package was put in the mail, Bolivia was thrown into turmoil when the military seized power there and the American ambassador was recalled. Even if the letter is received before the eclipse, the possibility of observers going to the limits to make useful timings is probably remote. Copies of the material were also sent to the Peruvian Astronomical Association in Lima, but weather prospects at the northern limit on the Peruvian coast are not good. In the next couple of months, the programs will be used to calculate the limits for the annular eclipse of 1981 February 5 in Tasmania and for the total eclipse of 1981 July 31 across the U.S.S.R.

In my article, "Two Occultations of Bright Planets in July," on p. 34 of the July issue of *Sky and Telescope*, the durations for the immersions of the Galilean satellites as a percentage of that for Jupiter were given. Unfortunately, when doing this calculation, I mistakenly divided the diameters of the satellites by the mean radius of Jupiter, so the published percents, and the satellite duration times in the example for Los Angeles, are twice as large as they should have been.

Paul Newman, Garland, TX, writes saying that he has commercial plans for a Lunar occultation observing aid which he designed and built. "It is a considerable modification/elaboration of a basic idea published in *O.N.* a few years ago. Its main features include an eyepiece with a translucent half-field occulting bar registered to a 6-inch diameter scale graduated in degrees, which turns against an illuminated index. It is most valuable for observing reappearances, but is also helpful for disappearances by subduing the intensity of the illuminated part of the Moon."

In the British Astronomical Association's Lunar Section *Circular* (1980 April) 29, Alan E. Wells, 22 Latelow Rd., Lea Hall, Birmingham, England, describes a "slave timer" which generates an audio tone at one-second and one-minute (longer tone) intervals. He says he will publish further information in the future, but notes that its construction is only suitable for an experienced electronics engineer since advanced methods are employed. He says that he is willing to build and supply some units at cost price, about £12. Electronic alarm clock/calculators which can now be purchased commercially have served a purpose similar to Mr. Wells' device by some graze observers.

GRAZES REPORTED TO IOTA

David W. Dunham

The table lists successful, or partly successful, expeditions for grazing occultations, reports of which have been received since the list on page 88 of the last issue was prepared. The format of the list was published in *O.N.*, 2 (3), 27.

Mo	Dy	Star Number	Mag	% Snl	CA	Location	# Sta	# Tm	C C	Ap cm	Organizer	St	WA	b
1979														
3	5	0671	3.6	45+		Memphis, TN	2	11	9	20	Jim Meadows			
4	18	2715	6.5	65-	6S	Spring Lake, FL	2	9	4	20	Tom Campbell	0	187	-37
9	12	094056	8.3	57-	8N	Hungry Valley, CA	3	15	7	15	Richard Nolthenius		354	72
9	16	1260	7.0	17-	7N	Pt.Wakefld,Austrl.	3	13	6	15	David Steicke	6S	350	31
10	24	2372	4.4	11+	-1S	Coonalpyn,Austrl.	2	9	8	15	David Steicke	6N	175	-70
11	25	164120	8.5	34+	2S	Culrurra, Austrl.	2	6	4	15	David Steicke	11N	179	-30
11	27	3360	6.3	56+	0S	Hamilton, N. Z.	2	12	7	6	Gordon Herdman		181	
12	10	Jupiter	-1.7	58-	5S	BlancheTwn,Austrl.	5	10	6	15	David Steicke	25S	184	-15
12	12	1758	7.0	40-	-0N	Whangarei, N. Z.	1	2	7	6	David Hickey		0	
12	28	0398	6.7	78+		Lladúrs, Spain	1	3		20	Carlos Schnabel			
12	29	0508	4.3	85+		Barcelona, Spain	7	16		6	Carlos Schnabel			
12	30	0692	1.1	93+	3N	Lockport, IL	11	71	8	13	John Phelps	5S	353	73
12	30	0692	1.1	93+	3N	Algonquin Pk,Ont.	2	2	9	9	Brian Burke	S	353	73
1980														
2	8	2072	6.7	59-	7S	Riverview, FL	5	29	7	20	Tom Campbell	3S	186	-48
2	10	2365	7.1	36-	7S	Blenheim, N. Z.	1	3	7	20	Brian Loader		189	
2	12	160867	8.2	22-		Sentmenat, Spain	2	2		6	Emili Capella			
2	21	0444	6.2	36+	6S	Offagne, Belgium	3	14	7	20	Jean Schwaenen		177	72
2	21	0444	6.2	36+	4S	Schkeuditz, G.D.R.	1	7	9	6	Christian Gottwald			
2	21	0444	6.2	36+	4S	Eilenburg, G.D.R.	4	20	9	6	Dietmar Büttner			
3	4	1821	2.9	95-	13S	Marietta, SC	2	12		20	Judy Overcash			
3	9	2372	4.4	59-	S	Bloemfontein,RSA	3	22		9	G. N. Walker			
3	20	093548	8.1	22+		Sabadell, Spain	5	13		14	Carlos Schnabel			
4	6	2497	6.6	72-	12S	Mt. Holly, NJ	5	21	6	13	David Dunham	4N	192	-55
4	7	2687	6.5	59-	11S	Whangarei, N. Z.	1	4	7	6	Terry Hickey		192	
4	9	2959	7.2	39-	6S	Richwood, TX	1	4	7	25	Don Stockbauer	2N	189	-22
4	18	0659	6.4	11+	3S	Edgar, VA	3	10	8	20	William Stein		184	69
4	18	0669	4.0	12+		Newburg, WI	12	47	8	15	Peter James			
4	18	0669	4.0	12+	2S	Collegeville, PA	1	4	5	13	Emil Volcheck			
4	18	0669	4.0	12+	2S	Mt. Holly, NJ	7	52	7	10	David Dunham	0	184	70
4	19	0832	4.7	21+	2N	Boron, CA	2	10	9	20	R. Lasher & C. Evans			
4	19	0832	4.7	21+	2N	Kramer Hills, CA	3	21	9	15	Richard Nolthenius	2S	4	63
4	22	097646	6.0	49+	5N	Kingsland, GA	1	8		15	Harold Povenmire			
4	22	1336	5.2	59+		Køge, Denmark	1	8		6	N. P. Wieth-Knudsen			
5	5	2760	6.7	76-	10S	Bradley, IL	1	7	4	20	John Phelps	6N	190	-37
5	5	2760	6.7	76-	9S	Edgar, VA	3	11	5	20	William Stein	N	189	-36
5	6	2908	6.9	66-	11S	Laceola, TX	1	4	5	25	Don Stockbauer	5N	192	-25
5	6	2908	6.9	66-	9S	Gilcrist, FL	1	0		15	Harold Povenmire			
5	22	1522	6.8	52+	5N	Edgewood, MD	2	7	7	25	David Dunham	3N	4	-6
6	15	1142	7.8	6+	3S	San Jacinto, TX	1	3	5	25	Don Stockbauer	1N	181	39
6	17	1466	5.2	25+		Cambrils, Spain	2	5		20	Carlos Schnabel			
6	18	1487	1.3	27+	N	Wolfe City, TX	1	9	9	8	Paul Newman			
6	18	1487	1.3	27+	N	Denham Springs,LA	3	12	8	10	Ben Hudgens			
6	18	1487	1.3	27+	4N	Flamingo, FL	15	60	9	25	Campbell&Povenmire	3N	3	-4
6	22	139229	7.5	65+		Pocahontas, MS	3	11	4	15	Ben Hudgens			
7	3	146589	7.7	71-		Pocahontas, MS	2	2	5	15	Ben Hudgens			
7	9	Venus	-4.1	8-	-11N	Chadds Ford, PA	1	1		25	Alfred Webber		4	65
8	5	0667	5.3	29-	7N	Chester, VA	8	44	8	10	William Stein	2N	350	71

On p. 88 of the last issue, it was noted that a latitude libration empirical correction which is applied by the ACLPPP is no longer valid. Further analyses have confirmed this conclusion, and another problem with the northern-limit empirical corrections applied by ACLPPP was revealed during the 1980 June 18 graze of Regulus (see p. 101). Since profiles for the rest of 1980 already have been distributed, observers should make corrections when appropriate when setting up expeditions, to avoid being too high or too low on the profile. First, be sure that the second line of the middle column of printed information below the profile says "PREPARED BY VERSION 78A." The observed Cassini graze data and other corrections applied by ACLPPP are not now valid for any other version, such as 80C. If the version is different, write to your computer asking for a 78A profile - it may take a few weeks to get it, since a computer run at USNO probably will be needed. The rules for the corrections which you should make to the 1980 profiles are given below:

1. These corrections apply only to northern-limit grazes (*i.e.*, those with central graze Watts angle between 0° and 30°, or between 330° and 360°).
2. Do not shift the Cassini points "3" or "4" on the profile, unless there is a line which says "OBSERVED DATA FROM GRAZE OF ZC 1234 11/13/76." For that graze only, and only for points with Watts angle of 355° or less, the "3" and "4" points should be shifted like the others of the profile.
3. The amount of the shift depends on the value for the LIBRATIONS - LAT, which is the top number of the column to your right in the printed information at the bottom of the profile. Call it b (this is the number in the right-most column of the list of observed grazes, which are given to

the nearest tenth of a degree with the decimal point removed). Then,

a. If b is greater than 2.5, shift the path south (perpendicular to itself, not due south) by the amount HEIGHT + VPC. This gives the shift in arc seconds (left scale on profile); convert it to miles or km by dividing by the VPS.
b. If b is in the range from 0 to 2.5, there is no correction to be applied.
c. If b is less than 0, but greater than -2.5, shift the path north (perpendicular to itself) by 0".3. Divide 0.3 by VPS for miles or km.
d. If b is -2.5 or less, no correction should be applied

The VPC, HEIGHT, and VPS values are in the middle column right under PREPARED BY VERSION. Notice that under the "D" in "PREPARED" there is a dash ("-") between the names and numbers. It is not a minus sign; if any of the numbers are actually negative, a minus sign will appear in the space immediately to the left of the number. For example, for a graze of ZC 405 on 1980 Sept. 27, I have a profile with Watts angle of central graze = 355.65, b = 7.35, VPC = 0.078, HEIGHT = 0.510, and VPS = 0.53 sec/mi. Under 3 above, case a applies and the shift south (down on the profile) is 0.510 + 0.078 = 0".588, or dividing by 0.53, = 1.11 miles, to the south. The message for the graze of ZC 1234 11/13/76 does appear so, according to point 2 above, only points with Watts angle less than 355° (near central graze) are shifted by the computed amount. Appropriate changes will be made to the ACLPPP computer program so that these corrections will not (and should not) be applied for 1981 grazes.

Discussions with Tom Van Flandern have revealed that some of my statements about Perth 70 stars for graze predictions published in previous issues are wrong. It turns out that different versions of the XZ catalog are used by versions 78A and by 80C (and later versions). The version used by 78A does not have Perth 70 data in it. The stars north of declination -4° in both versions are the same, but in the newer version for Perth 70 stars south of declination -4°, Perth 70 data have been combined with the earlier data taken from either the ZC or SAO catalogs. So when using 78A profiles for these southern stars which are in the Perth 70 as listed in the incomplete table of *o.N.* 2 (1), 10, a correction for Perth 70 can be obtained from me if 3 or more stations are planned and the date and position angle of graze are provided. Recent comparisons have shown that the Perth 70 catalog has not been as rigorously corrected to the FK4 as was claimed, so that the resulting positions may or may not be better than a ZC or Yale position (although the statistics favor Perth 70). In general, anything is better than a GC position. If you have a Perth 70 or Yale shift for a graze, it is safest to take the inside track, that is, the one that puts you deepest in the profile to avoid having a miss.

The new IBM 4341 computer was installed at USNO in April, as described in IOTA NEWS. Fortunately, the old magnetic disk packs can be read and used by the new machine, so we have been able to use version 78A. A new operating system, MVTRES, is planned for the computer which will make it increasingly difficult to use the old disks, including the one with version 78A of the OCC program used for all our basic calculations. MVTRES was scheduled to become operational on August 1, but various problems have forced postponement. In the future, it will be much easier to use the current version, which now is 80C. During the last several weeks, we have calculated graze reduction data for many of the best-observed expeditions during the last few years. Hank Sielski has helped with the keypunching of station coordinates needed for this undertaking and Robert Sandy, Kansas City, MO, is busy drawing the reduction profiles using the computed data and the observer timing reports. Copies will be distributed to observers at a future date, and hopefully there will be room to publish some of the more interesting ones in *o.N.* Calculations are being done with both versions 78A and 80C so that we might be able to determine corrections for ACLPPP applicable for 80C. In any case, the 78A version corrections will be improved. Several Cassini grazes are included in the reductions, so these can be added to the ACLPPP observed graze data base. Sandy's work has already shown that there are sometimes significant changes with longitude libration as well as latitude libration.

Observers are reminded that daytime grazes are not included in our usual IOTA/USNO graze prediction coverage. You can learn of these events from USNO total occultation predictions, or total predictions or graze maps prepared by HMNAO; we will compute them for you upon request. Since the new USNO computer is much faster than the old machine, this economy will no longer be needed and daytime grazes will be included in our coverage for 1981 onwards. In fact, all graze predictions could be computed at USNO with the IBM 4341, but this will not be done until the double star data base is completely automated. Unfortunately, it does not appear that this will be accomplished in time for the 1981 predictions. If and when this does come to pass, we expect to still distribute graze data to Bode for European graze calculations, and to Senne to handle new requests, but not to the other computors.

An attempt to observe grazes of the same occultation from both the northern and southern limits is described on p. 100. Although this attempt failed, another opportunity, involving Jupiter's satellite Io, was presented in July. As noted in my article on p. 34 of the July issue of *Sky and Telescope*, infrared observations of the occultation of Io were to be attempted at Mauna Kea Observatory, Hawaii, where the event was nearly grazing (in fact, a partial occultation of Jupiter was predicted). It turned out that the University of Manitoba's observatory, at Glenlea, was located in the Io partial occultation zone at the northern limit, and conditions might be sufficient to observe the event visually. I have not heard from Hawaii, but Richard Bochonko reports that overcast skies prevented observation in Manitoba. It is doubtful that accurate-enough results could be obtained for the Lunar diameter with an extended Solar System source like Io; a star would be preferred.

Graham Blow reports that 23 stations were set up near Invercargill, in the southernmost part of New Zealand, for a graze of Regulus on February 2, but like other large expeditions for the same event in Australia, the effort was clouded out. The Regulus jinx is hard to break!

Except for a daytime graze of Aldebaran in Florida, the only good graze accessible to many observers during the last really favorable North American

Hyades passage of the current series (see p. 126 of the 1980 Aug. issue of *Sky and Telescope*) on Aug. 5 involved ZC 667 = 75 Tauri = SAO 93950, mag. 5.3. We knew that the multiple events range would be narrow for this northern-limit graze, so we wanted to compute the best prediction possible based on previous graze observations - the event was partly in the Cassini region. Indications from a graze of the same star observed on 1978 September 22 in the upper Midwestern USA were that there might be a significant north shift, while most northern Hyades grazes observed recently have shifted south. Fortunately, a graze of ZC 667 was observed in nearly the same Watts angle range in Japan in 1979 October. We prepared a good predicted profile for the event based on the Japanese and 1978 observations, with some details of the profile added from other recently observed Hyades and Aldebaran grazes. Paul Maley reported that over 20 stations would have been established in the Galveston, TX area, over 40 miles away for most of his observers, remarkable for a weekday morning event. But instead they had their first rain in over a month. I have not heard from the other planned expeditions, but DC-area observers drove 120 miles south to Chester, VA, to establish 8 stations. Although the weather did not look good in the evening, it improved, as predicted, after midnight. We set up over a range of only 1 km. The prediction was nearly perfect; the northern station had one short occultation while all the others recorded multiple events. A few events at the end were lost due to a patch of cloud. We also timed several total occultations of Hyades stars, stopping twice during the return trip for this purpose. The shift with respect to the ACLPPP profile was about 0".2 north; it would have been 0".7 north if the corrections described above had been applied. ZC 667's duplicity did not cause step events, either because the secondary was south of the primary, or so close that it was evident only as an enhancement to the diffraction pattern, perhaps the reason for some of the gradual and partial events we observed. Separate components for double stars should be reported only when distinct step events are timed for visual graze observations. We hope to do much better, perhaps set a record, during a Saturday evening graze of the 4.4-mag. spectrum binary ZC 3237 = ι Aqr on Nov. 15-16. In DC, the path crosses the Mall from the Capitol to the White House; it also passes near Philadelphia, New York City, Providence, and Boston. We might establish a graze shift hotline, as we did for Regulus in June, since observers in southern TX or near Baton Rouge, LA, could provide significant warning. The AIRN ham radio net (see p.104) might be used for this effort.

OCCULTATIONS OF FIRST-MAGNITUDE STARS AND OF PLANETS BY THE MOON, 1980 - 1982

David W. Dunham

This is the title of a useful publication by Jean Meeus, Heuvestraat 31, 3071 Erps-Kwerps, Belgium. It is published by the Vereniging voor Sterrenkunde, Ringlaan 3, 1180 Brussels, Belgium. Included are Besselian elements for all occultations of Aldebaran, Regulus, and the planets through the end of 1982, formulae for computing the northern and southern occultation limits and times of immersion and emersion (and position angle and altitude) for a given station, examples of these calculations, and programs for doing the calculations using HP-67 and TI-59 pocket calculators. Formulae for calculating the Besselian elements are also given. The elements are better than those published previously since second order terms are included, as well as terms to take into account the motion and distance of planets.

EXPERIMENT ON DIMENSIONAL STABILITY OF FOLDED MAPS

Don M. Stockbauer

In the article ACCURATE GEOGRAPHIC COORDINATES (see *O.N. 1* (10), 107), Thomas H. Campbell, Jr., warns "Never use a folded map if you expect to get accurate results. Creases cause a map to shrink. Use only maps that have been stored flat or rolled." As several maps in my collection are folded, I decided to run an experiment to obtain some quantitative results on this.

The 1:24000-scale USGS map "Kendalia, Texas" was used. First, the map was unrolled, and sixteen distances were measured on it. Then each distance was remeasured with the map lightly folded, i.e., not folded to extremely sharp creases. Then the map was folded to very sharp creases and remeasured. It was also noted over how many creases each measurement crossed. Readings were made with a 30 to the inch scale, and were read to $^1/_{300}$ inch. A two-power magnifier was used and each reading was triple checked. The results, below, are in thirtieths of an inch:

Measurement Number	Flat Map	Lightly Folded Map	Change	Severely Creased Map	Change
1	121.0	120.9	-0.1	121.0	0.0
2	115.8	115.8	0.0	115.8	0.0
3	112.7	112.9	+0.2	112.9	+0.2
4	99.0	99.0	0.0	99.1	+0.1
5	119.6	119.5	-0.1	119.5	-0.1
6	130.7	130.6	-0.1	130.5	-0.2
7	149.5	149.4	-0.1	149.3	-0.2
8	174.8	174.7	-0.1	174.4	-0.4
9	110.6	110.4	-0.2	110.4	-0.2
10	119.2	119.2	0.0	119.2	0.0
11	151.0	150.9	-0.1	150.8	-0.2
12	194.3	194.3	0.0	194.2	-0.1
13	177.4	177.3	-0.1	177.0	-0.4
14	156.8	156.6	-0.2	156.3	-0.5
15	126.1	126.0	-0.1	126.0	-0.1
16	145.5	145.3	-0.2	145.2	-0.3

Measurements 1-4 crossed no folds, 5-8 crossed one fold, 9-12 crossed two folds, and 13-16 crossed three folds.

A thirtieth of an inch corresponds to about 0.66 second of latitude on a 1:24000-scale map. The most severe shrinkages were on the order of 4 to 5 three-hundredths of an inch, or about 0.3 second of arc. There seems to be a general trend toward worse shrinkage the more severe the fold and with a greater number of folds. However, in many of the cases, the shrinkage was about the same as the inaccuracy of measurement. If a folded map must be used and few or no severe creases are crossed during measuring, accurate results probably will be obtained. If measurements are made to the nearest 2½-minute mark, I think it would be very rare to cross two or three creases unless the map was folded to a very tiny packet. Also, I think a map is rarely folded as sharply as my 'severely creased' map was; probably 'lightly folded' is nearer the truth. The map was uncreased by hand rather than ironed out; ironing might have improved the results. Constructive criticism would be welcomed, as well as the results of anyone else who has studied the matter.

A NEW ZEALANDER MAKES WOPAI

Harry O. Williams

During a relatively short period of observation and timing of total lunar occultations a number of minor difficulties have been encountered, not the least of these being the locating of the position angle on the limb, especially when attempting a reappearance. After some thought, I have evolved a helpful gadget, or "gizmo" if you are World War II, known as a "WOPAI" (Williams Occultation Position Angle Indicator), and consisting of only three components:

1) a 360° large diameter perspex [Ed: Plexiglas or Lucite] protractor fitted to the outside of the eyepiece tube and made to be rotatable and lockable;
2) an eyepiece fitted with a pointer which is extended to reach the scale of the protractor. This eyepiece and pointer must be able to be turned freely through 360° by finger and thumb;
3) one half of a deep red or amber filter which must be fitted to the eyepiece at its focal plane and in such a manner as to bisect the viewing field, leaving one half filtered and one half clear.

To use the WOPAI, set the telescope up as usual, and focus on the moon. Before starting the drive, adjust the rotatable eyepiece until a prominent lunar feature will drift from end to end *along* the straight edge of the half filter. Now rotate the *protractor* until the zero comes under the pointer which is attached to the eyepiece and then tighten the locking screw to hold it there. The pointer now will be indicating degrees of position angle.

To locate any other P.A., say 60°, turn the *eyepiece* until the pointer is reading 60° on the protractor, and then using the slow motion controls, adjust the telescope position until the filter edge is tangent to the moon's limb. If the filter edge is nicely in focus this may be done quite easily and with some exactness, and the apparent point of contact between the filter edge and the moon's limb will be the location of P.A. 60°.

When used on the following limb at say P.A. 270° where the lunar image is brilliant, the dense filter will cut off most of the light, while also indicating the exact spot where a P.A. 270° reappearance would occur.

In constructing this device, I used a perspex protractor 150 mm in diameter, with the central bar removed. The protractor is mounted on a disk of $^1/_8$-inch or no. 10 aluminium and is also backed with a white card to make for easy reading. The whole assembly must, of course, move as a unit to and fro as the telescope is focused.

The protractor is graduated both clockwise and anticlockwise, thus permitting use either with or without a diagonal in the optical system.

My WOPAI has been in use on my 21-inch equatorial Cassegrain since mid-1977, and I am continually amazed at its accuracy and dependability.

NEW DOUBLE STARS

David W. Dunham

Table 1 lists additions and revisions to the special double star list of 1974 May 9 not listed in previous issues. The columns and general format were described on p. 3 of *O.N. 2* (1).

Two of the entries in Table 1 are based on speckle interferometric observations which made it necessary to revise the double star codes for the stars. As more and more speckle observations are accumulated, mainly due to the work of Harold A. McAlister of the Department of Physics, Georgia State University, Atlanta, GA, we not only get good measurements of the separations and position angles of the brighter occultable close doubles, but can now give rates of change for these parameters as well. It will not be long before orbits can be computed for many of these close pairs. McAlister's latest publication is "Speckle Interferometric Measurements of Binary Stars. IV" (hereafter called "Paper IV"), *Astrophys. J. 230*, 497 (1979 June). It gives references to the earlier papers in the series, but the following error in the references should be corrected: The Paper III *Astrophys. J.* volume is *228*, not the printed 230. In addition, Frank Fekel has supplied me with a preprint of Paper V. Fekel coauthored Paper V with McAlister, and both made the speckle observations at Kitt Peak National Observatory, AZ. Since both P.A. and sep. are observed, the speckle data are preferred over one-dimensional occultation data. There is a 180° ambiguity in the P.A. from speckle data, but this can often be resolved by either direct visual or occultation observations. Photoelectric occultation observations can also give better measurements of component magnitude differences. An effort is made to put occultation doubles on the speckle observational programs, but the most recent occultation discoveries, and the fainter earlier ones, have not yet been observed by speckle interferometry. However, as observational techniques improve, fainter magnitudes are being reached, and more data can be collected and processed, so that a survey of the brighter stars is planned (rather than the past practice of only observing known or suspected doubles).

Except for the two cases listed in Table 1, discussion of speckle observations below will be limited to stars which will be occulted during the next couple of years; revisions for other stars will be published in a future issue. Many of the stars observed by speckle methods already have orbits determined from earlier visual observations. McAlister compares his observations with published orbits in his papers. The orbits for SAO 97645 = ZC 1236 = ζ Cnc = ADS 6650AB and for SAO 146498 = ZC 3388 = 83 Aqr = ADS 16497AB agree very well with the most recent speckle observations. At 1978.62, the companion of SAO 93870 = ZC 636 = 55 Tau = ADS 3135 was 4°.6 higher in position angle than the value computed from the orbital elements. At the same epoch, the companion of SAO 93925 = ZC 659 = 70 Tau = Fin 342 had a P.A. 8°.5 less than that computed from Couteau's orbital elements published in the I.A.U. Double Star Commission's *Circulaire d'Information* No.

Table 1. NEW DOUBLE STARS, 1980 AUGUST 10

SAO/BD	ZC	M	N	MAG1	MAG2	SEP	PA	MAG3	SEP3	PA3	DATE, DISCOVERER, NOTES
93757*		T	K	9.0	9.0	0".15	90°				1979 Jan 9, P. McBride, Green Forest, AR
93803*	0618	P	V	7.3	10.0	.058	77				1978 Oct 19, D. Evans, McDonald Observatory, TX
93925*	0659	P	O	7.0	7.3	.1316					1978 Sep 22, J. Eitter and W. Beavers, Ames, IA
94020		T	K	8.8	8.8	0.06	116				1980 Mar 21, W. Rothe, East Berlin, G.D.R.
94220		T	K	8.2	8.2	0.1	90				Early 1980, Mr. Mooney, Co. Wexford, U.K.
95748*		P	G	7.7	10.3	2.2	142	10.8	".052	43°	1978 Nov 18, D. Evans, McDonald Obs. (comp. BC; ADS 5121)
96335	1060	T	K	8.2	8.2	0.03	30				1980 May 18, P. McBride, Green Forest, AR
96378		T	K	8.9	8.9	0.2	100				1980 May 18, P. McBride, Green Forest, AR
96851		T	K	9.8	9.8	0.1	110				1980 Apr 21, P. McBride, Green Forest, AR
98427	1371	I	V	7.2	7.2	0.06	77				1978.1466, last obs. by H. McAlister, KPNO, AZ
110118		T	K	9.4	9.4	0.04	5				1980 Jan 24, P. McBride, Green Forest, AR
118820		V	Z	8.8	8.8	0.97	0	13.5	6.2	61	Orbit by Baize, last obs. 1976.79 (comp. AB; ADS 8145)
138721*	1772	I	L	4.9	5.4	.008	0	5.4	.118	150	1976.0364, H. McAlister, KPNO, AZ (3rd star)
+18° 1212		T	X	9.2	9.2	0.06	145				1980 Apr 20, R. Hays, Worth, IL *=X09020=AGK3 N18° 594
+17° 477		V	O	8.3	9.0	.297	0				Orbit by Erceg, last obs. 1976.94 *=X03998=AGK3 N18° 231 (ADS 2301)

59, with good agreement in separation. Other orbital elements for this fast-moving pair failed to predict the P.A. by more than 50°. The speckle observations have shown that the orbit determined for SAO 98427 = ZC 1371 = 81 Cnc = Fin 347Ap no longer represents the pair's motion. No orbit has been determined for SAO 98161 = ZC 1321 = ADS 7039, but the speckle observations agree well with values extrapolated linearly from earlier visual observations as given in the Stockbauer list of visual occultable doubles.

Stars with improved position angles and separations, and their annual rates of change, are listed in Table 2. The values for 1980.00 are given, followed by the yearly change. If no rate is given for the separation, the observations have not enabled a good determination, and the separation has been assumed to be constant, with its value found by averaging all available speckle measurements.

Table 2. Parameters for Some Occultable Stars Improved with Speckle Interferometry

SAO	ZC	Name	Double	Pos. Angle 1980	Rate	Separation 1980	Rate
78423	0995	ν Gem	ADS5103	123°9	+4°15	".116	+".018
80491	1329		Cou 773	41.3	+1.55	.233	+.008
95166	0913	64 Ori		52.9	-5.93	.057	
98427	1371	81 Cnc	Fin 347	208.8	-72.24	.2	
138721	1772	η Vir		248.0	+24.72	.10	
146954	3514	24 Psc	Fin 359	240.7	-7.68	.093	
161848	2731		Kui 88	167.6	-0.80	.410	+.003
165359	3356	74 Aqr		155.9	+25.10	.074	
186575	2642	17 Sgr		136.8	+1.07	.288	+.008

Most of the data in the table were computed from observations in Paper V and in the earlier speckle papers. For SAO 80491, 146954, and 161848, earlier direct visual observations were also used. For SAO 95166, Paper V data were combined with a two-occultation determination published in *Astron. J. 82,* p. 631 as well as in *O.N.* The orbit determined for SAO 98427 does not fit the speckle data, which have been used exclusively for preparing the data in Table 2. There is considerable change in separation, with observed values ranging from ".060 to ".162; the pair seems to have a period of about 5.0 years with periastron in late 1976.

The two stars with newly-determined orbits are listed in the I.A.U. Double Star Commission's *Circulaire d'Information* No. 81 (1980 June). In that Circular, the IDS and name for ADS 3032 are wrong; the correct IDS is 04045S0812 = BD -8° 798 which, unlike the given IDS 04041N2351 = ADS 3033, is not occulted by the Moon, and is not a close visual pair like ADS 3032.

Although data for the appropriate occultation doubles had been sent to me earlier, some errors have been corrected based on information in the University of Texas' "Photoelectric Observations of Lunar Occultations. XI" in *Astron. J. 85,* p. 478 (1980 April), as given in Table 1. Improved magnitudes are given for the components of SAO 93925. In the notes on p. 486, Run 4890, the SAO number is wrong; it should be 159887. The Texas observations indicate that the P.A. of ascending node of the orbit determined for SAO 93925 = 70 Tau needs to be augmented by 180°. A good photoelectric record for SAO 159098 showed no evidence for duplicity; the Lick IDS has mag. secondary = 99.9 with both P.A. and sep. = 0, so the star apparently is not double. Good traces for SAO 96727 (R at P.A. 319° on 1978 Nov. 19 and D at P.A. 92° on 1979 Feb. 9) and SAO 109888 (R at P. A. 269° on 1978 Aug. 22) show no sign of the possible duplicity indicated by South African visual occultation observations in 1928 and 1922, respectively. The A-BC pair for SAO 95748 is listed in the IDS, but the star is not marked as double in the SAO catalog, so this duplicity was not shown in my previous lists. SAO 93803 was observed twice at McDonald Obs., but the P.A.'s were so similar that a solution for P.A. and sep. was not possible; averaged data are given in the table. The spectrum binaries SAO 118847 and 161883 were not resolved during occultations at McDonald; apparently, the components are separated by at most a few milliarcseconds.

During the favorable Hyades passage of 1980 April 18, we observed a graze of 4.0-mag. SAO 93955 = ZC 669 = θ^1 Tauri from central New Jersey. Robert McCutcheon observed from a site 155 yards south of my position, since this distance corresponded to the predicted separation of 0".06 of the components as projected into the position angle of graze, 175°. In spite of the 7° altitude above the horizon, I had no difficulty in timing the events of the 7.8-mag. secondary star. Since the timings were in good agreement with McCutcheon's timings for the primary, the parameters for this close double must be essentially correct. In *O.N. 2* (7) 71, SAO 93975 = ZC 677, another bright Hyades star, was noted as a possible double based on graze observations, but this was not confirmed by a photoelectric record at McDonald Observatory on 1979 March 5.

On 1980 Jan. 4, Terry Hickey, Whangarei, New Zealand, tried to time an occultation of non-SAO X13174 = BD +17° 1904, but never found the star, whose mag. was given as 7.9. He easily timed a 7.9-mag. event earlier in the evening. As noted in *O.N. 2* (6) 58, many of the XZ mags. are in error. The correct AGK3 mag. is 9.4; the Catalog of Stellar Identifications gives 9.1. Since the X-AGK3 mag. difference was 1.5, X13174 was not in Table 1 of *O.N. 2* (6) 59.

REGULUS, AN IMPORTANT BUT JINXED STAR

David W. Dunham

Regulus (ZC 1487 = α Leonis) is the only first magnitude star which is close enough to the ecliptic that occultations of it occur in the same libration ranges as Solar eclipses. Hence, like occultations of stars during Lunar eclipses, discussed in *O.N. 2* (4) 34, occultations involving Regulus, especially grazing ones, have special value for improving our information of those parts of the Lunar profile needed for analysis of Solar eclipse observations for accurately measuring the Sun's radius. Regulus is the only star which can be used for this purpose and which can be reliably observed in the daytime and against the Moon's bright limb. Regulus occultations provide the best opportunities for eclipse Lunar profile studies outside of Lunar eclipses. In fact, Regulus is the only first magnitude star which can be occulted during a total Lunar eclipse.

Historically, Regulus occultations have been important in other respects. It was the first star to have its radius determined during an occultation. During a Regulus occultation on 1933 April 3, Albert Arnulf used the 1-meter Paris Observatory f/3 reflector at Meudon to record the star's light as it disappeared on a photographic plate traveling 3 to 6 cm/sec. The trace was analyzed with a microphotometer and the star's diameter determined to be less than 0".003, and estimated to be between 0".0015 and 0".0020, according to *Comptes Rendus 202*, 115 (1936 January). Although a few photoelectric records have been made of Regulus occultations, as far as I know, conditions for these have not been ideal, or there have been instrumental problems, so that a good photoelectrically determined diameter is not yet available, and even a very close companion can not yet be ruled out.

As far as I know, the first expedition for a grazing occultation was also for Regulus, also on 1933 April 3. According to *J. Brit. Astron. Assoc. 43*, 281 (1933 May), twelve sites were established from 1.5 miles outside the predicted northern limit to 6.5 miles inside the limit, along the Canterbury-Dover Road near Barham and Elham, England. The members of the expedition met at the White Horse Inn, Bridge, and from there set out under a completely cloudy sky for their posts. Some of the observers saw Regulus through gaps in the clouds shortly before the occultation, but no events were observed due to the clouds. Stopwatches would have been used to time the duration of the occultation. Dr. Steavenson had a chronograph for recording multiple events at one of the stations. The northern limit had been computed by Mr. J. T. Foxell, who had published a detailed map of the occultation in England in a previous issue of *J. Brit. Astron. Assoc.* Foxell himself observed the occultation as a near graze in clear sky. From his site in a yard behind the Crewe Railway Station, the duration was about 6 3/4 minutes, as noted on p. 303 of the same *J.B.A.A.* volume. He made a good timing of the instantaneous disappearance, but muffed the difficult bright-limb emersion.

Of special value for eclipse analyses would be observations of grazes at both the northern and southern limits of the same Regulus occultation. In May, 1970, during the last series of Regulus occultations, the northern limit crossed New Brunswick and Nova Scotia, Canada, while the southern limit passed near San Diego, California. Expeditions were planned for both areas, but both were clouded out. As far as I know, grazes of the same star during the same occultation have never been observed at both limits. Regulus was the last occultable first magnitude star observed to be grazed. Two observers saw multiple events during a graze of the star in Nairobi, Kenya, on February 29th this year, but the graze had not been predicted and they were not prepared to make timings.

The first timings of a Regulus graze were made during the occultation of 1980 June 17-18, discussed in my article in that month's issue of *Sky and Telescope*. The northern limit crossed the U.S.A. from Washington state to Florida, so prospects for extensive observations were good. About ten days before the occultation, Eric Bram requested information about the northern limit extended eastward, since he planned to be on Guadalupe Is. in the Caribbean at the time, and wondered if he might be able to observe the graze. A few days later, while at USNO, I computed the eastern part of the path, finding that it crossed a couple of remote Bahamian islands and passed north of all the others; Eric would have to settle for a total. At the same time, I decided to calculate the southern limit, finding that it crossed a remote part of southern Peru with the Moon nearly setting. But farther west, I found that the southern limit crossed the Island of Hawaii, passing several miles south of Mauna Kea! Since the event would occur at about 2 pm local time, it would not disrupt the observatory's nighttime observing, so working with Dr. William Sinton of the University of Hawaii, an expedition for the southern graze was planned. Hasty arrangements were made to send Richard Nolthenius, UCLA, from California to Hawaii, so that an experienced graze observer could lead the effort.

Meanwhile, elaborate plans were being made to observe the northern-limit graze across the U.S.A. The path is shown on my map on p. 87 of the January issue of *Sky and Telescope*. Large expeditions were organized by Robert Schiffer in New Orleans, LA, and by Tom Campbell and Harold Povenmire in the Florida Everglades, where the dark-limb graze would be spectacular in a relatively dark sky. Other expeditions were organized north of Dallas, TX (graze at sunset), and near Shreveport and Baton Rouge, LA. As there have been no recently observed Regulus grazes, it was felt that observations of the graze by small expeditions in the western U.S.A., in daylight, could be valuable for alerting the large eastern expeditions to any unexpected shift in the graze path, which the predicted profile showed would be less than 2 km wide. Observations in Washington could give a 1½-hour warning to Florida observers, and observations in Colorado could give nearly an hour's warning. Richard Linkletter organized an expedition to Chehalis, WA, with radio ham cooperation to relay information about an observed shift directly to a message center at Goddard Space Flight Center, manned by Robert W. Vostreys. Linkletter did not have predictions for the event in his IOTA graze predictions, which for 1980 do not include daytime events; as noted in a previous issue, 1980 daytime events have to be requested and specially computed. Detailed predictions were computed quickly and sent to Linkletter. He found that the path passed within 5 miles of the active Mt. St. Helens volcano, but found relatively ash-free sites far to the west of the mountain. Derald Nye led an expedition to Pueblo, CO, to provide a second chance in case of clouds in Washington.

Joan and I planned to observe the graze from either New Orleans or the Everglades, depending on which would have the better weather prospects. The trip had to be quick, due to our work and attendance at the American Astronomical Society's meeting that week at the nearby University of Maryland. Shortly after noon of the 17th, we found out that extensive cloud cover was associated with a front extending from Arkansas to the Carolinas; the farther south away from the front we could get, the better our chances would be. So we caught a flight to Miami to join the Everglades expedition. There were many clouds from a large thunderstorm, the only one in Florida, about 25 miles northwest of our site, but the moon moved into a large section of clear sky a half hour before the graze. We telephoned the Goddard "hotline" to find out that both the Washington and Colorado expeditions were clouded out. So we observed from our assigned site established according to the predicted ACLPPP profile. Mosquitoes from the surrounding swamps filled the air. Liberal amounts of insect repellent slowed their attack only slightly. They especially liked my right hand, which I had to use to steadily support the small borrowed unmounted telescope which I used throughout the graze period. A few clouds from the now-disintegrating thunderstorm blocked the view for several seconds at some stations, including ours, causing the loss of a few timings. Nevertheless, the graze was spectacular and worth the hardships, but for us very expensive, since we could get no discount fares on what must be one of the highest-priced air routes in the U.S.A. We ended up paying $165 per event timed, which is a record which probably will stand for a long time. I think the previous record was $50 per event when Richard Nolthenius had to have his car engine rebuilt after a breakdown while returning from a graze in Arizona several years ago.

We might have been able to obtain a few more timings if we had had warning of a sizeable (0.8 km or 0".3) north shift which occurred, causing us to miss the top of the profile. Nevertheless, the expedition was quite successful overall, with 62 timings from 15 stations; a couple of other stations timed the total occultation from sites a few miles south of the graze path to extend the position angle coverage of the observations, which could help for eclipse analyses. One observer attempted the graze from Key Largo, the only other place in Florida where the graze crossed a road, and was clouded out.

Schiffer's expedition, with 14 stations set up along Canal Blvd. in New Orleans, had clear skies and obtained 64 timings. The graze was recorded on video tape by a crew from a local television station; unfortunately, they were at one of the few sites which had only one disappearance of Regulus. Although most events were sharp, several gradual and partial events were seen, apparently due to visibility of the diffraction pattern for such a bright star at gently-sloping Lunar features. One of the Florida observers claimed that a small circle of light tangent to the star and the Moon's limb appeared just before immersion and again briefly after emersion.

Ben Hudgens reports that observers from Houston, TX; Jackson, MS; and Baton Rouge, LA, converged on Denham Springs, LA, just east of Baton Rouge, where one cloud obscured the view for all but three observers. In any case, a good account of the effort was published in *The Denham Springs and Livingston Parish News* of June 19th, which quoted one resident: "27 days without rain and then when this occurs we get a cloudburst." Paul Newman successfully observed the graze north of Dallas, TX, and I understand that an expedition from Shreveport, LA, also got data. Overall, the northern limb of the Moon was very well observed. But Nolthenius brought disappointing news when he returned from Hawaii. The jet stream drove a solid layer of altocumulus clouds over Hawaii during the day; since they were at 24,000 feet elevation, they even prevented timing the total occultation at Mauna Kea. Simultaneous north-south graze observations during the same occultation for accurately measuring the Lunar polar diameter have yet to be made.

Upon examining the corrections applied by the ACLPPP computer program, I discovered the cause of the north shift. For negative latitude librations, southward corrections of 0".3 to 0".5 are applied to northern-limit profiles. These corrections were determined from observations of grazes with large negative latitude librations several years ago; they were applied to prevent large numbers of miss observations, and were quite successful. But during the last few years, all favorable northern-limit grazes have occurred with positive latitude librations; this Regulus graze was one of the first ones to have a negative latitude libration, and by only a small amount (-0°.42). Since it is so close to zero, the southward correction applied apparently is not valid and should be gradual, proportional to the size of the negative libration. Corrections for future grazes to eliminate this problem are described in my article on grazing occultations on p. 95.

After Regulus, what is the next brightest star which can be occulted at librations which are useful for Solar eclipse analyses? At a central (total or annular) Solar eclipse occurring at the Earth's center, the Lunar latitude libration, and the ecliptic latitude of the Moon's center, are zero. But central eclipses are observed from the Earth's surface, so the latitude libration can be as large as the maximum Lunar horizontal parallax, 61' 30" or 1°.03. Hence, observation of any graze with latitude libration, given in the lower right of the ACLPPP profiles, in the range ±1°.03 can help define part of the Lunar profile needed for Solar eclipse work. Since grazes occur at the Moon's limb, not its center, the possible ecliptic latitude of stars is greater by the maximum apparent Lunar radius of 16'

46". Hence, the range of stellar ecliptic latitudes is ±1°30. Bright stars within 1°79 of the ecliptic are listed by G. P. Können and J. Meeus in their good article, "Occultations of Bright Stars by the Eclipsed Moon," *J.B.A.A. 85*, p. 17 (1974), noted in *O.N. 1* (5) 41. After Regulus, whose ecliptic latitude is +0°46, the brightest stars in the desired range are α Librae (Zubenelgenubi) and β Scorpii (Acrab), with ecliptic latitudes of +0°34 and +1°01, respectively. Both are magnitude 2.9, bright enough for daytime or bright-limb observation under good conditions by experienced observers with good telescopes. Next are the 3.2-mag. stars η and μ Geminorum (Propus and Tejat), which might marginally be observed under daytime or bright-limb conditions. Grazes at both the north and south limits of occultations of fainter stars might be observed if both grazes occur on the dark limb. This can happen if the northern and southern graze expeditions are separated considerably in longitude, since the position angle (and cusp angle) of graze changes along the path. Simultaneous north-south grazes might be arranged more easily during a total Lunar eclipse, the next one being in 1982.

[Note added August 16:] Richard Radick, Sacramento Peak Observatory, Sunspot, NM, reports that he obtained a high-quality photoelectric record of an occultation of Regulus at Cerro Tololo Inter-American Observatory, Chile. The diameter he derived from the observation, with a formal error of only about 0.0001 arc seconds, is in good agreement with the value determined from the Narabri intensity interferometer observation. There is no sign of duplicity. A good record of the June 18th occultation was also obtained at KPNO, according to Don Wells.

For the 1933 April occultation, it turns out that Foxell's location at Crewe, England, was at a central graze depth of only 2"8 below the mean limb, which would place him on a modern-day ACLPPP profile. If we define a graze as occurring if any events are seen and the observer is within 3"0 of the mean limb at central occultation, which has been our operational definition, then Foxell was the first person to travel to a predicted graze path with portable equipment and observe one, not Len Kalish in California in 1962. However, unlike Foxell, Kalish saw more than one occultation of the star. Another observer of the 1933 April occultation timed both immersion and emersion at Birkenhead, England, where the central depth was 3"1. This was reported in the summary of 1933 occultation observations in *J.B.A.A., 45*, 107 (1935). I do not know if the Birkenhead effort was an expedition or a home station observation (no other events were reported there that year).

PROBABLE DUPLICITY OF PALLAS FROM SPECKLE INTERFEROMETRY AND SOLAR SHRINKAGE FROM ECLIPSE DATA REPORTED AT A. A. S. MEETING

David W. Dunham

From 1980 June 15 to 18, the American Astronomical Society held its 156th meeting at the University of Maryland in College Park, MD. The A.A.S.'s Division of Dynamical Astronomy met concurrently on the 18th, with more paper sessions the next two days. Abstracts of the main A.A.S. meeting papers have been published in *Bull. Amer. Astron. Soc. 12* (2) 443. Of the many papers presented, the one of most interest to *O.N.* readers is probably one on speckle interferometric observations of asteroids reported by Richard Radick of Sacramento Peak Observatory. Coauthors are E. Hege, W. Cocke, E. Hubbard, M. Gresham, and P. Strittmatter of Steward Observatory and S. Worden of Sacramento Peak. The observations were made with the Steward Observatory speckle camera on three nights in 1979, September 12 and 13, and November 10. Of approximately ten asteroids for which the data have been reduced, eight appear round and single, including Ceres, Juno, and Vesta. But Pallas showed a pattern more like that of a double star with a feature which changed in position angle at a rate consistent with the known rotational period. The observations seem consistent with a close satellite 1/5th the size of Pallas (or about 100 km in diameter) in synchronous orbit. Radick noted that only a very unlikely lopsided distribution of surface albedo features could give such results. The data imply an orbital plane which is not in agreement with the photometrically-determined pole of rotation. However, this location of the pole may be in error by 20° or so, more than the formal standard error, which could eliminate the conflict. The other asteroid showing duplicity was (12) Victoria, with a separation large enough (about 1") that it might be resolved directly under very good conditions. Since there was only one observation, the orbit is not known and the satellite's location can not be predicted for the occultation on 1980 October 26. Much of the speckle data has not been reduced. In the meantime, occultations by Pallas and Victoria should be given special attention.

Alan Fiala, USNO, presented his and my preliminary analysis of our observations of the total Solar eclipse of 1980 February 16 (reported on p. 83 of the last issue), in comparison with similar analyses of Baily's bead timings made during the 1979 and 1976 Solar eclipses. During the month before the meeting, working with Thomas Van Flandern, we had developed computer programs to calculate, for each observed time, where the limbs of the Sun and the Moon intersected, and plot the Watts profile in the vicinity of those points. The program selected a Watts feature which probably caused the bead event(s), but this could be overridden manually after inspection of the printed profile. The final program, a modification of one used to analyze asteroid occultation observations, reads the reduced data and uses the method of least squares to solve for corrections to the position of the relative centers and radii of the Sun and the Moon. David Herald's analysis of the Australian observations of the 1976 eclipse was used to check our programs. The corrections to the relative centers were less than 0"1 in both R.A. and Dec. for all three eclipses, giving us confidence in Van Flandern's (actually, corrected J.P.L. DE 102) ephemerides and our calculations. As we had determined from less-complete earlier work, there was no change detected in the relative radii from 1976 to 1979. However, from the eclipses of 1979 February to 1980 February, we found that the Solar radius had decreased by 0"25 ±0"10! A more recent analysis including David Herald's observations of this year's eclipse gives a smaller decrease of 0"10 between the two eclipses, when there was a considerable increase in Solar activity related to the sunspot cycle. Further analyses are in progress.

Also during the main A.A.S. meeting, William Penhallow reported methods he has recently employed to improve astrometry for planetary occultation predictions, including the mapping of errors across the plate based on reference star residuals. The consistent astrometry he got for the recent (59) Elpis event indicates that he's on the right track. Wayne Warren, Jr., manned a poster exhibit describing the work of the National Space Science Data Center at Goddard Space Flight Center. The Astronomical Data Center was developed to acquire, check, document, maintain, and distribute astronomical data in machine-readable form. Much of the work relates to star catalogs and their improvement. Several listings of the available data were distributed.

During the morning of June 19th, several workers from USNO's Nautical Almanac Office gave papers reporting their current research. Richard Schmidt discussed the XZ catalog, including current and future improvements. T. Van Flandern and M. Lukac described their analysis of 150,000 Lunar occultation observations back to 1820. They derived an improved determination of ΔT (Ephemeris Time minus Universal Time) over the time span. They showed that the Earth's rotation rate changed by 3 parts in 10^{10} (one second per century) during an interval of less than a year in 1896. Polar motion was likewise anomalous then. This change is larger than any other on record, yet is not known to be correlated with any purely geophysical event.

NEWS OF RECENTLY-ATTEMPTED PLANETARY OCCULTATIONS

David W. Dunham

(9) Metis and SAO 80950, 1979 December 11: Jack McConnell, Merida, Venezuela, has sent another negative report of this occultation, made at El Junquito (longitude 67°.10 W., latitude 10°.52 N., height 1526 m) west of Caracas. This position is closer to the Barquisimeto path than Merida, but is still 51 km away. Hence, as reported on p. 86 of the last issue, there were still no observers close enough to the Barquisimeto path to confirm or deny their secondary occultation observation. Jack McConnell did not realize this before I talked with him at the A.A.S. meeting in College Park, MD, in June, but still remains skeptical of the Barquisimeto observation. If a satellite did cause the reported secondary observation, circumstances should be good enough that at favorable oppositions, observations by speckle interferometry should reveal it. Perhaps such observations were made during the favorable early 1980 opposition, but have not yet been reduced.

(3) Juno and SAO 115946, 1979 December 11: At the June A.A.S. meeting, Larry Wasserman, Lowell Observatory, informed me that analysis of the 15 observed chords of this event has been completed and a paper is in preparation. He noted that there were 2½ visual chords (one observer detected only the emersion) which were in essential agreement with the photoelectric data, showing that such observations are possible for even a small Δm event like this one. Wasserman said that the artificial star tests conducted at Lowell (*O.N. 2*, p. 52) indicated that a Δm of 0.4 would be just marginally detectible by visual observers, which seems to be proven by the visual observations of the Juno event. He said that the personal equations reported by the visual observers all had to be increased by a few tenths of a second to agree with the photoelectric data. I suspect that this is because, for a difficult event, there is a decision time involved rather than just a reaction time, and most observers tend to underestimate the time to decide that the event has really occurred when they assign a value to the personal equation. A design for a completely electronic digital reaction time tester, with circuit diagram, has been published in the B.A.A. Lunar Section's *Circular 15*, p. 57 (1980 July). He notes that the effect of a simulated occultation can be improved by placing the LED in the focal plane of a telescope, so that, with a faint setting, the decision time might also be measured.

Pluto and an unnamed star, 1980 April 6: I was mistaken in my notice about this event dated 1980 March 12, in saying that Pluto's probable satellite Charon would be south of the planet. The correct northern elongation was reported on *I.A.U. Circular* No. 3464 (1980 March 31), which noted, "an occultation by 1978 P 1 is not particularly likely, but this object may be only 0".1-0".2 from the star around Apr. 6^d23^h." Two circulars later, dated 1980 April 10, an occultation of the star was reported by A. R. Walker, South African Astronomical Observatory, Sutherland. The 50^s occultation, centered at $23^h39^m28^s$ UT, was recorded photoelectrically with the 1-m telescope. The event was probably caused by Charon, which is deduced to have a minimum diameter of 1200 km. R. Harrington, USNO, reports that analysis of astrographic plates taken on April 13 and 20 by C. Dahn and J. Christy support the conclusion that the occultation was caused by Charon. Unfortunately, no other reports of the occultation are known. Some observers in Europe well north of the path reported no occultation.

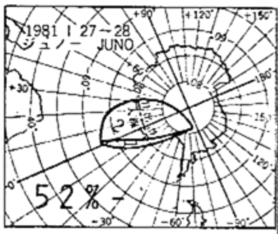
(59) Elpis and SAO 162018, 1980 June 15: This event was mentioned on p. 84 of the last issue. Regional maps and Gordon Taylor's finder chart, which had two stars in Aquila incorrectly labeled as being in Aquarius, were distributed to observers in the possible areas of occultation in Europe and eastern North America. Plates of Elpis taken by Penhallow on May 17th showed that Elpis was 0".2 south of its predicted path, indicating that the path of occultation might cross North Africa and the Carolinas. However, Elpis was near a stationary (in R.A.) point and its p.a. of motion would change by 64° by the time of the occultation. Hence, rather than referring the shift to its current path, it would probably be more correct to take the correction to Elpis' position from Penhallow's plates and project it onto the direction of motion for June 15th. When this was done, it showed a strong north shift of 1".4, putting the path in Scotland and southern Greenland. This was confirmed by further plates taken by Penhallow on June 6th and 12th, the latter also including the star for an accurate final prediction. These showed that the path would be 1".3 north, which also agreed with last-minute astrometry by Gordon Taylor who predicted that the path would cross Labrador, southern Scotland, and northern England. It was good to see such consistent astrometry for the event, probably mainly due to improvements in Penhallow's measuring engine environment and plate reduction software at the University of Rhode Island. Since there was no mention of the event in the B.A. A. Lunar Section's *Circular* for 1980 July (an earlier issue had mentioned the event, noting the possibility of it occurring in the U.K.), apparently no

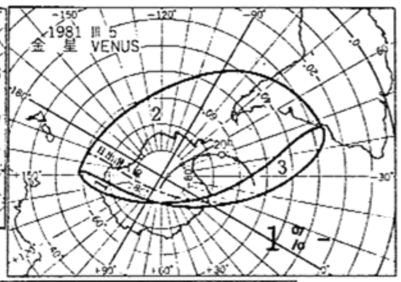
observations were possible due to bad weather. It was clear in the DC area and other parts of the northeastern U.S.A., but haze and low altitude prevented even locating the star.

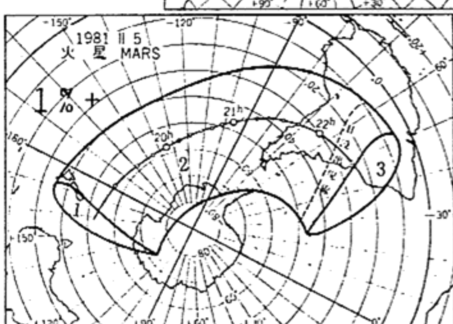
LUNAR OCCULTATIONS OF PLANETS

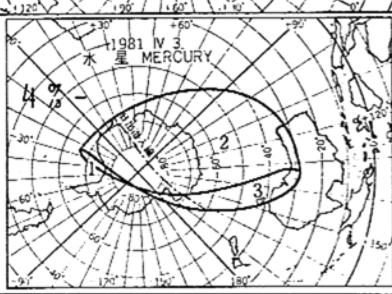
The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission, from the Japanese Ephemeris for 1981, published by the Hydrographic Department of the Maritime Safety Agency of Japan. In region 1, only the reappearance is visible; in region 3, only disappearance may be seen. Reappearance occurs at sunset along a dashed curve, while disappearance is at sunrise along a curve of alternating dots and dashes.

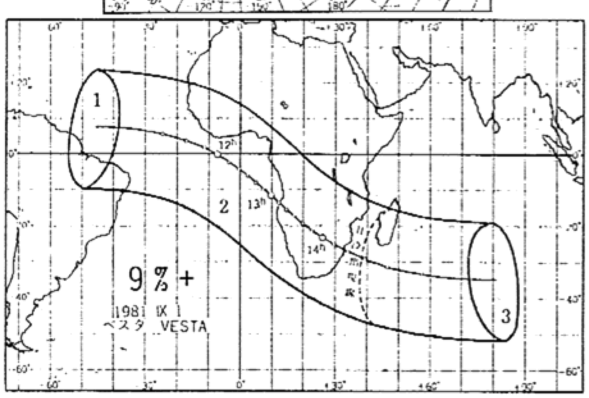
Observers interested in observing partial occultations should request predictions at least three months in advance, from Joseph Senne, P.O. Box 643, Rolla, MO 65401, U.S.A., telephone 314,364-6233. For further details, see *O.N. 2* (6), 54-56.











PLANS FOR UPCOMING ASTEROIDAL OCCULTATIONS AND OTHER PLANETARY OCCULTATION NEWS

David W. Dunham

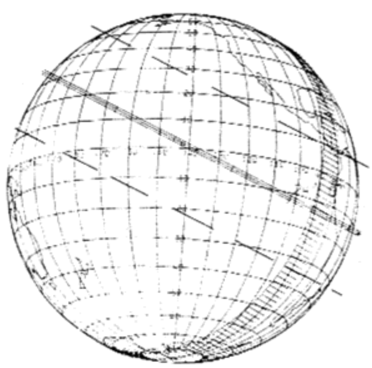
A computer program which I wrote to compute local circumstances of asteroidal and planetary occultations and appulses was described in *O.N. 2* (7) 62. Joseph E. Carroll, 4261 Queens Way, Minnetonka, MN 55343, phone 612,938-4028, now has this program operational on a computer to which he has access at work. Predictions of local circumstances can be obtained by sending him your geographical coordinates and a long, self-addressed, stamped (if you live in the U.S.A.) envelope. These predictions will be for the remainder of 1980 for all asteroidal and planetary appulses which occur with the occulted star above your horizon. It is expected that data for 1981 events will be available sometime in September.

Derek Wallentinsen's predictions of asteroidal occultations, entitled "Occultations by Minor Planets. 1979 - 1982," is published as *Contribution* No. 2 of the James-Mims Observatory, dated 1979 September 6. A copy can be obtained by sending $3.00 to the James -Mims Observatory, P.O. Box 15854, Baton Rouge, LA 70895, U.S.A. In addition to listing the circumstances and path coordinates for each of the 76 occultations which he found, he also lists 21 near misses, 143 close appulses, and 13 passages of minor planets across galactic clusters. Derek Wallentinsen also prepared "Phase Minima of Fourteen Minor Planets. 1979 - 1982," also utilizing the ephemerides which I supplied, for *Contribution* No. 3 of the James-Mims Observatory, 1979 September 9, cost 40¢.

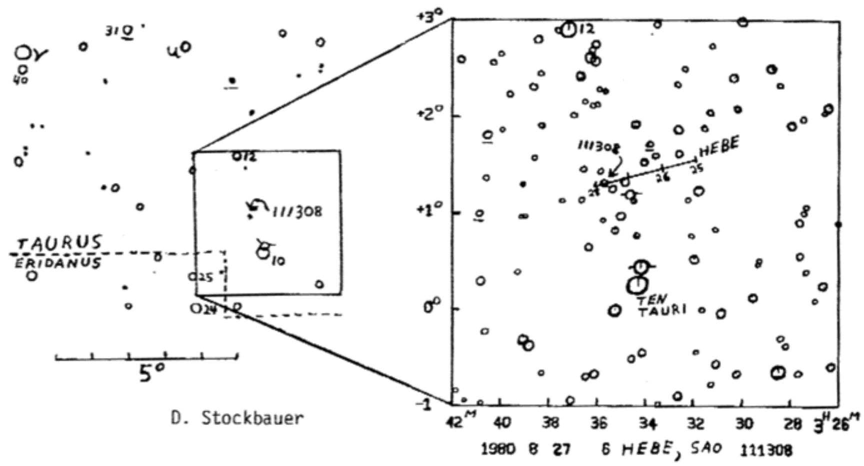
Asteroids, a recently-published book giving much detailed information about minor planets (1182 pages), can be obtained for $19.95 from the University of Arizona Press, Tucson. The chapters of the book are developed from papers presented during the 1979 March meeting on Asteroids in Tucson; Tom Gehrels is the editor. Most of the latest work and theories about asteroids are presented (including Van Flandern's, Binzel's, and Tedesco's chapter on minor satellites), as well as comprehensive tables of orbital elements, magnitudes, classifications, families, names, poles and rotation periods, etc., which are listings of the computerized Tucson Revised Index of Asteroid Data (TRIAD).

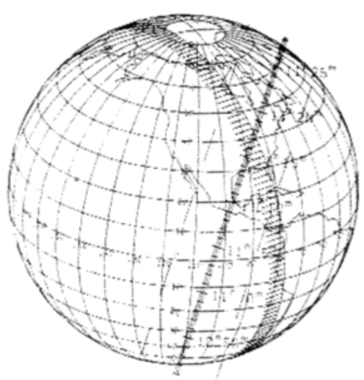
Paul Maley, working with Houston-area radio hams, has established the Asteroid Intercept Radio Net (AIRN), which is coordinated by Bill Shoots (call letters K5BY), 709 Ballentine, Seabrook, TX 77586, phone 713,474-3695. The AIRN will meet every Sunday night on 3935 KHz at 10:30 pm Central Time. The main purpose of AIRN will be to disseminate asteroid occultation path prediction improvements, especially those based on last-minute astrometry. Interested observers are invited to contact a local amateur radio operator who is capable of operation on single side band on 75 meters. The expected nationwide occultation by (134) Sophrosyne on 1980 November 23 was the main reason for establishing AIRN, but it will be used for other asteroid events, such as the one by (78) Diana on September 4. AIRN might also be used to provide real-time Lunar grazing occultation shift information for widely-separated expeditions. Derald Nye, Longmont, CO, is looking into the possibility of having brief messages about last-minute asteroid occultation predictions broadcast by WWV. If radio means don't work, those with portable equipment willing to chase asteroid occultation paths in their region can usually obtain the latest prediction information by telephone from Gordon Taylor at the Royal Greenwich Observatory, England, phone 032-181 3171, or from Lowell Observatory, Flagstaff, AZ, phone 602,774-3358, or from me at 301,585-0989 (home) or 589-1545,ext. 358 (work). As stated previously, those who do not have portable equipment are encouraged to monitor asteroid appulses from fixed observing sites whether the occultation is predicted in your region or not, due to the possibility of recording a secondary occultation; for such events, confirmation by observation from pairs of nearby but separated (independent) stations is important. Paul Maley continues to stress such observations in articles which he has published in various popular astronomical magazines. One we recently learned about is in the Polish *Urania*.

Regional maps and finder charts for the occultations by (6) Hebe on 1980 September 15, by (12) Victoria on October 26, and by (28) Bellona on 1980 November 10 were distributed to all *O.N.* subscribers in the eastern third of North America, along with Lunar grazing occultation expedition information and data for the past (59) Elpis event of June 15. The data for the first two events were also distributed to central North American subscribers with charts of the August 16th occultation by (11) Parthenope, which will occur before this issue is distributed. Hence, the possible regions of visibility of these events have been covered, so maps and finder charts

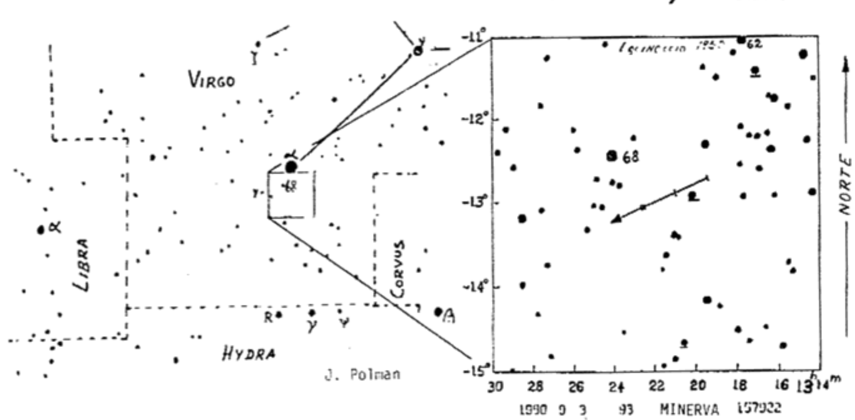


SAO 157922 by Minerva 1980 Sep 2-3

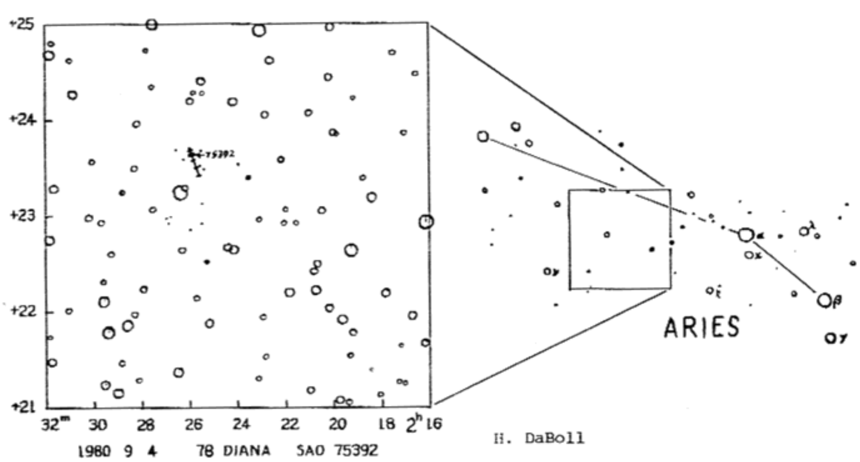




SAO 75392 by Diana 1980 Sep 4



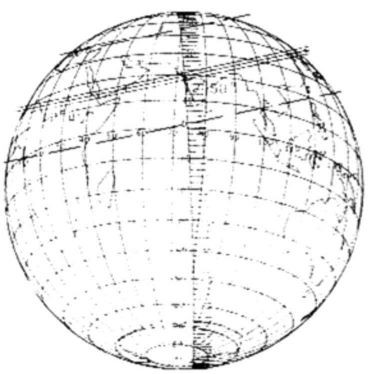
SAO 159307 by Aspasia 1980 Sep 14



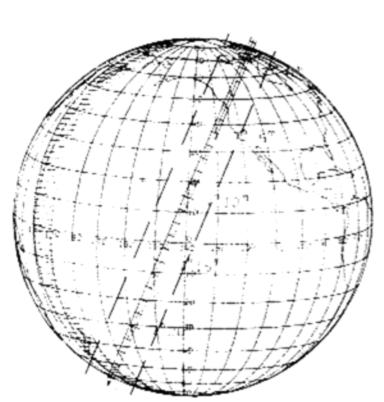
for them will not be published in *O.N.* If you live in the eastern two-thirds of North America and for some reason did not receive information about any of these events, write to me at P.O. Box 488, Silver Spring, MD 20907 and I will send you a copy of my notice for East Coast observers.

Larry Wasserman and others at Lowell Observatory have recently extended their work reported in *O.N.* 2 (4), 32. By automatically scanning recently-exposed Lowell plates, they are searching for occultations of uncataloged stars by some of the larger asteroids. They found one event involving Vesta which might be observed photoelectrically from the Far East on 1980 November 3. Details about this event, and some plans for specific upcoming events, are given below. The Lowell astronomers are working on astrometry for some other events they have found; since they are mainly occultations of faint stars by bright asteroids, photoelectric observations will be required for most of them.

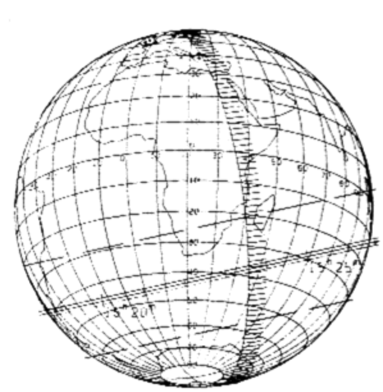
(78) Diana and SAO 75392, 1980 September 4: A finder chart and some information about this occultation are given on p. 121 of the August issue of *Sky and Telescope*. Penhallow and Klemola plan astrometry to improve the prediction for this event; a preliminary result might be available in time to add a last-minute note in this issue. This event may provide the first opportunity to disseminate last-minute predictions by the AIRN radio net and/or by WWV. An expedition for the occultation is planned by the University of Arizona, by Lowell Observatory, and by IOTA, the latter effort being coordinated by Paul



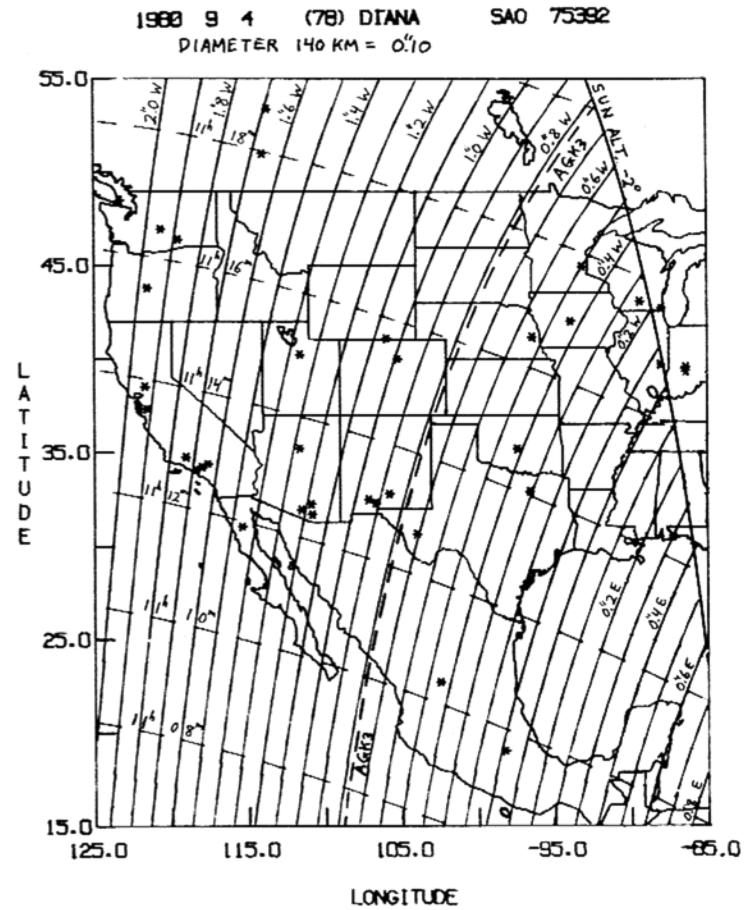
SAO 187358 by Eunomia 1980 Oct 6

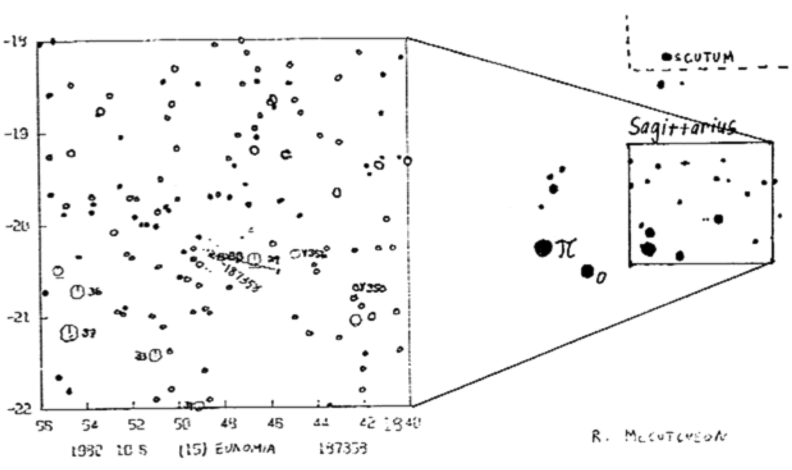


SAO 128066 by Kleopatra 80 Oct 10



SAO 162353 by Eunomia 1980 Oct 26

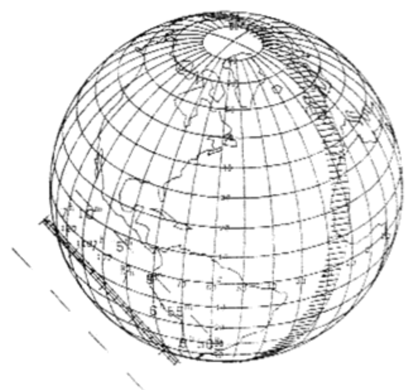




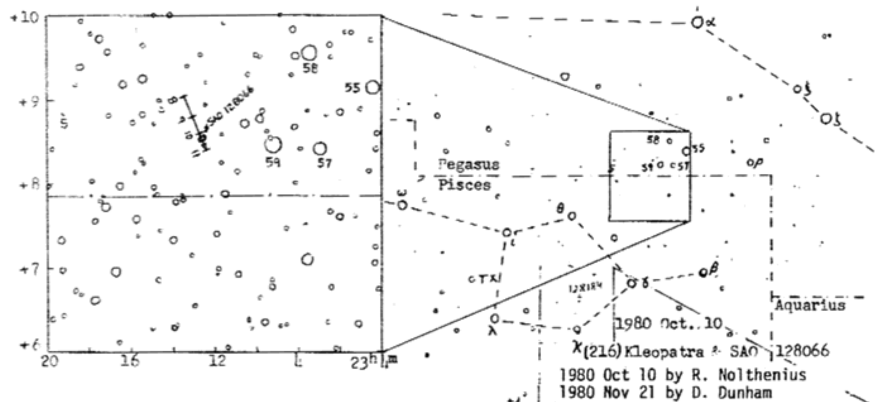
Maley and me.

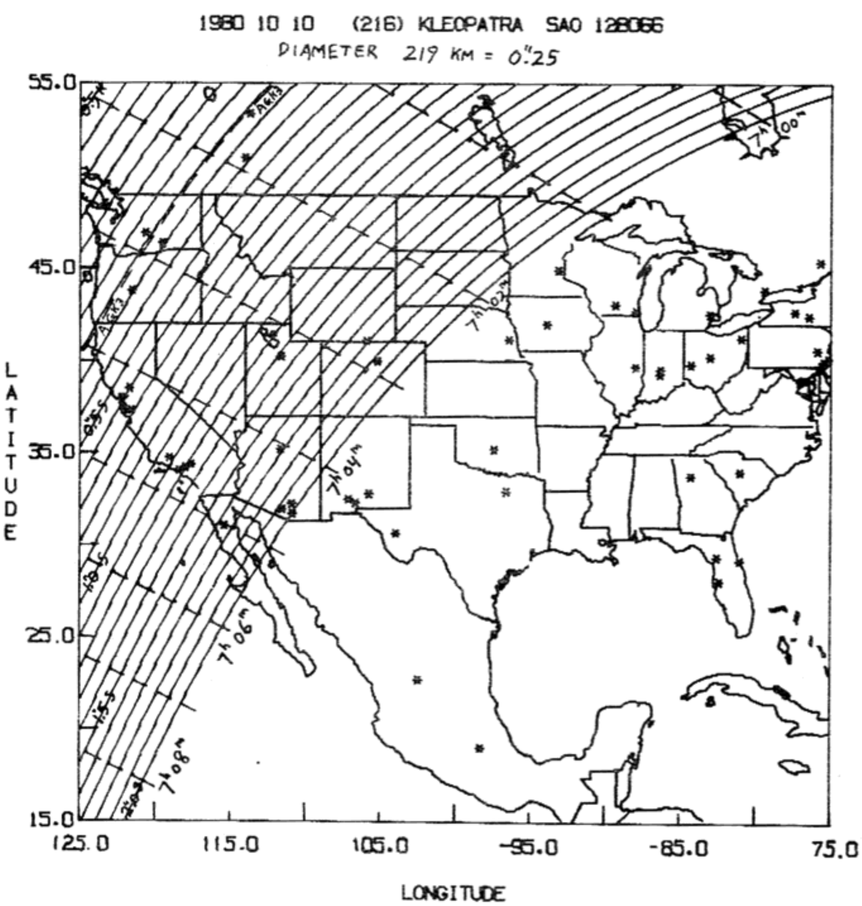
(6) Hebe and B.D. -1° 569, 1980 September 15: Photometers will be required to record this small Δm occultation. Astrometry is planned by Penhallow and Klemola. Astronomers from Massachusetts Institute of Technology, the University of Maryland, and Lowell Observatory are planning a joint expedition. Others with photometers at fixed observatory sites in eastern North America are encouraged to monitor this event, as well as the other possible occultations in the area during the rest of 1980.

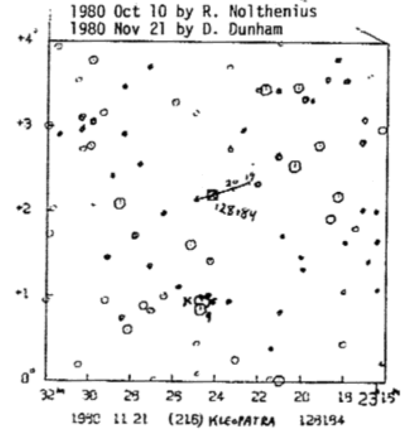
(216) Kleopatra and SAO 128066, 1980 October 10: Klemola obtained a plate when Kleopatra passed about 2° from the star in June. Wasserman reports that his analysis of the measurements of this Lick Observatory plate indicates that the nominal path across western Washington state is essentially correct. David Tholen, University of Arizona, has made photometric measurements of Kleopatra indicating that it is a very unusual object. Its lightcurve is found to have an amplitude of about 1.4 magnitudes, one of the largest for an asteroid, indicating a highly elongated object. Also, the type has been found to be M or E, rather than a low-albedo C object expected from earlier measurements. Hence, instead of being 219 km in diameter, the value used for my maps, the maximum diameter is expected to be within the range 126 km to 59 km, while the minimum diameter would be half this size. So the occultation path could be very narrow. Further photometric and infrared measurements are planned to get an improved estimate of the size. More astrometry is planned by

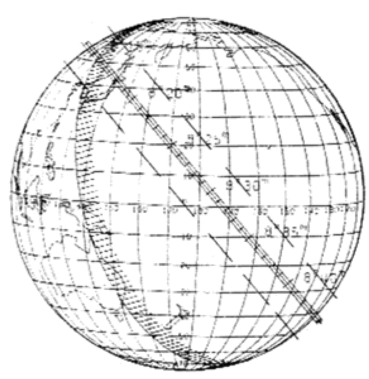


+33°1129 by Aurora 1980 Nov 2









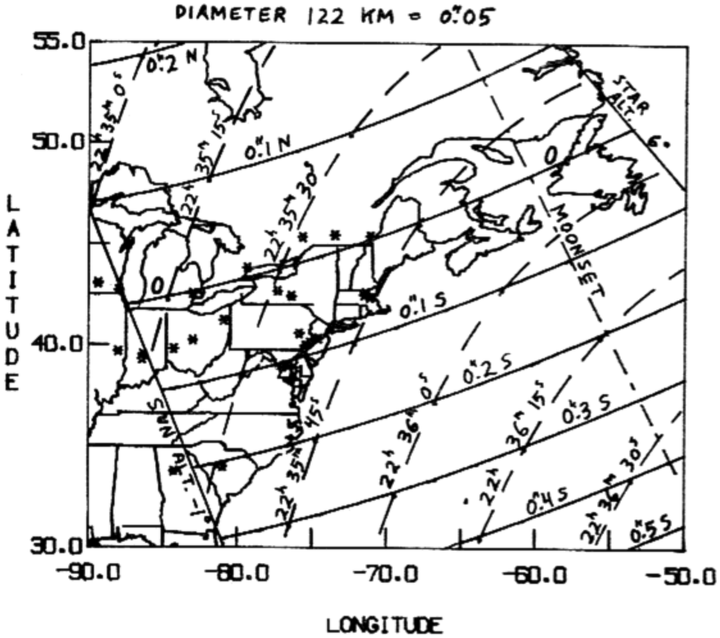
SAO 128081 by Kleopatra 1980 Nov 6

Klemola at Lick Observatory, and expeditions may be mounted by Lowell Observatory and IOTA, depending on late astrometric results and the weather. The IOTA effort will be coordinated by Paul Maley and Richard Linkletter.

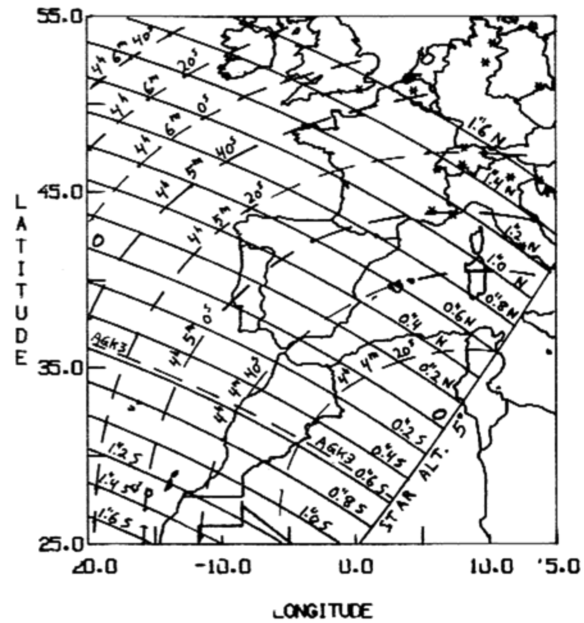
(12) Victoria and B.D. +1° 2457, 1980 October 26: This event will be of much interest due to the possible distant satellite of Victoria indicated by speckle observations; see p.102. Astrometry will be rather difficult due to a relatively small elongation. Depending on astrometry and weather, an IOTA expedition, and probably one from M.I.T. and the University of Maryland. An occultation should not be difficult to detect visually with a 5-inch or larger aperture telescope; due to the possibility of a secondary occultation, everyone with the star above their horizon in a dark sky is encouraged to monitor the event. The Sunday morning time of the event (note that the switch from daylight to standard time takes place that night) will facilitate long-distance travel. I will coordinate the IOTA effort. A Lunar graze of Aldebaran will occur less than 2 hours after the Victoria event; the graze path crosses the Gaspe Peninsula, which is also in the nominally-predicted Victoria occultation path.

(4) Vesta and A.C. +15° 9^h56^m 102, 1980 November 3: This is the occultation found recently at Lowell Observatory noted above. The parameters for the occultation, arranged in the same order as the tables on pages 63 and 64 of *O.N. 2* (7), but omitting the SAO and DM numbers, and the unknown stellar diameter and AGK3 number, are as follows: Table 1: Nov 3,

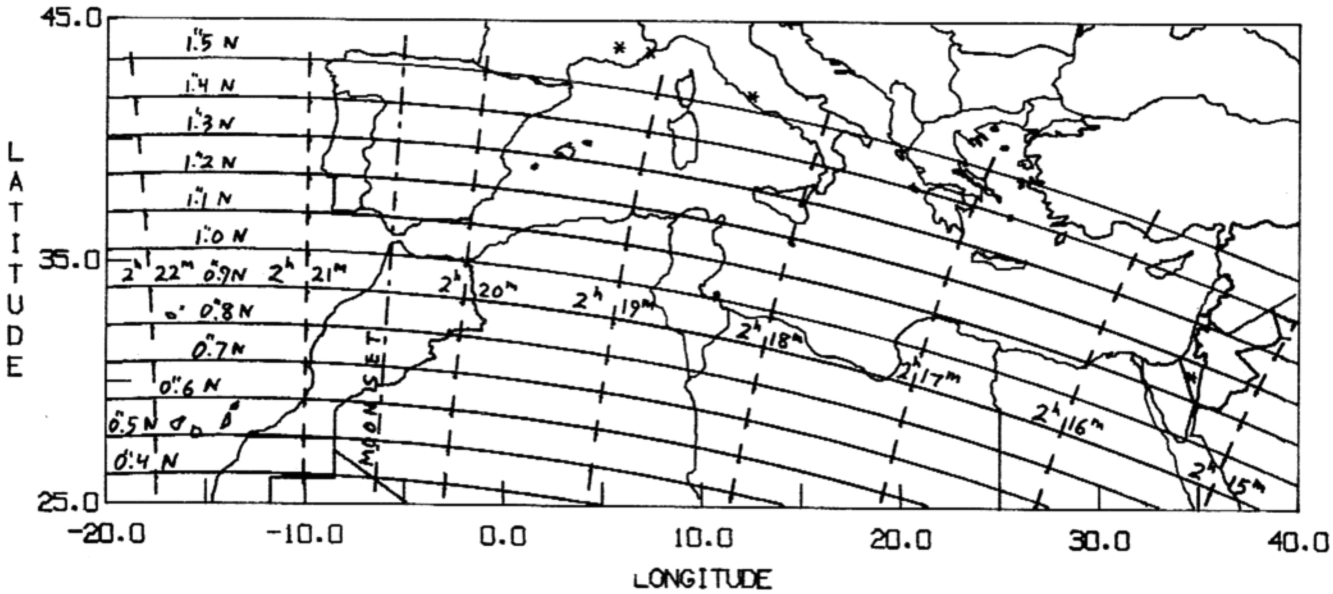
1980 11 10 (28) BELLONA SAO 161869
DIAMETER 122 KM = 0".05



1980 11 24 (134) SOPHROSYNE SAO 74963
DIAMETER 116 KM = 0".12



1980 12 17 (54) ALEXANDRA SAO 79914
DIAMETER 180 KM = 0".10



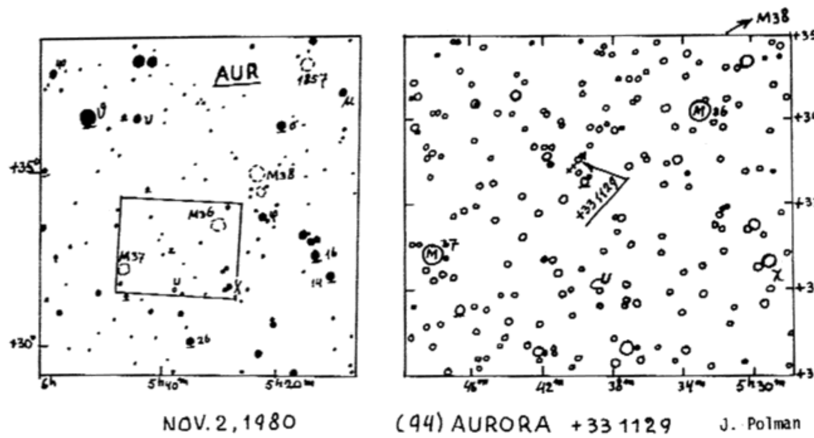
19^h56^m, Vesta, 8.1, 2.57, 12.6, $10^h01^m.9$, 14°45', 0.04, 21^s, 12, 7, China, Korea, and Japan, 74°, 30°, 14-, e 105°E. Table 2: Nov 3, 4 Vesta, 549 km, 0".29, 4113 km, 0°.330/day, 103°, -3".4, $0^m.9$, $10^h03^m.6$, +14°36'. The star's spectral type is also unknown; the magnitude given for the star and the Δm are photographic. Photometry of the star is planned at Lowell, and astrometry at Lick. The small magnitude drop will make even photoelectric detection a little difficult. The prediction is based on a position for the star measured with respect to SAO stars from a Lowell plate taken 1980 February, and is expected to be accurate to about 1". The large shift value listed would put the path in Western Australia and is based on the 1904 Bordeaux Astrographic Catalog position reduced with AGK2-3 data. The Lowell position should be the better one due to the 76 years of accumulated proper motion since the A.C. plate was exposed.

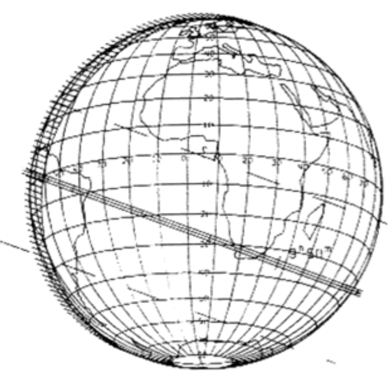
(216) Kleopatra and SAO 128081, 1980 November 6: Klemola's June astrometry for this asteroid, noted above, implies a 0".98 south shift for this event, and a correction to the time of $-0^m.4$, putting Japan closer to the path.

(28) Bellona and SAO 161869, 1980 November 10: An eastern North American expedition may be organized, depending on astrometry and the weather. Astrometry will be difficult due to the small elongation, and impossible for Penhallow and USNO, both of whose western horizons are blocked.

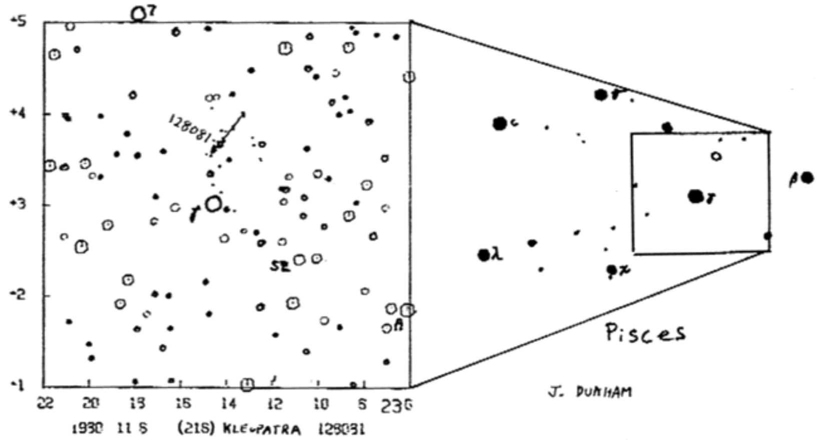
(216) Kleopatra and SAO 128184, 1980 November 21:

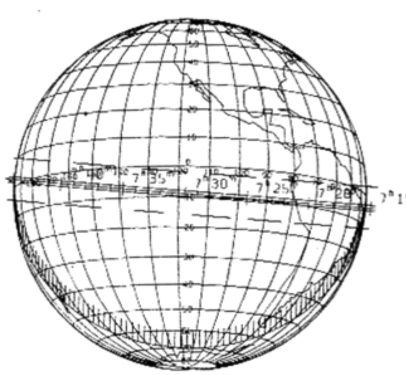
SAO 161869 by Bellona 1980 Nov 10



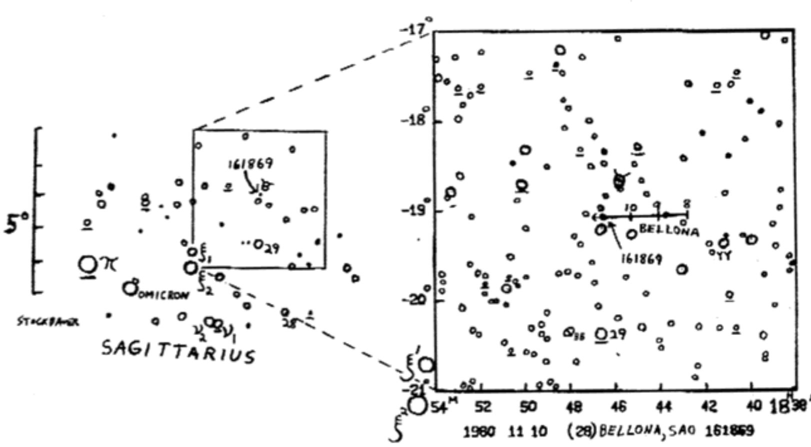


SAO 158406 by Fortuna 1980 Nov 19





SAO 130705 by Hebe 1980 Nov 20

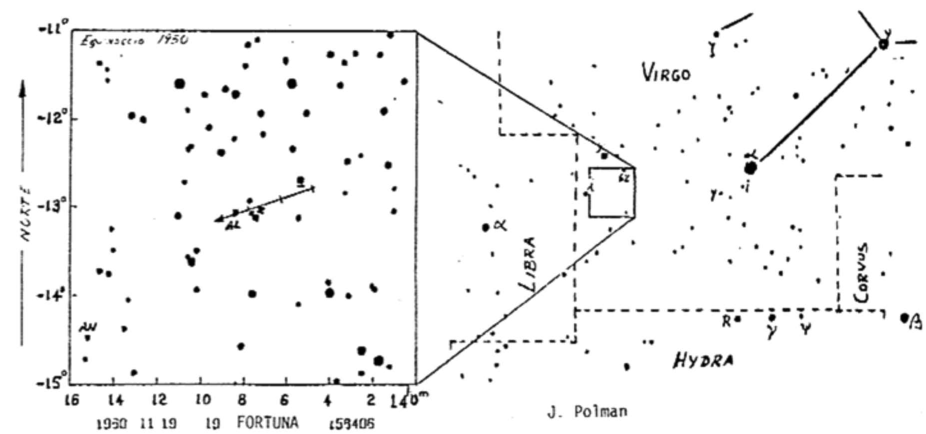


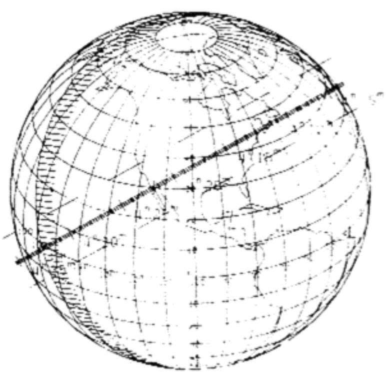
Klemola's June astrometry noted above implies a 0".96 south shift and a time correction of $+0^m6$. The shift puts the path across southern Peru and Brazil. This combined with the recently-determined smaller size of the asteroid, making accurate path prediction more difficult, virtually rules out a previously contemplated North American expedition to observe the occultation of this bright possible double star.

(134) Sophrosyne and SAO 74963, 1980 November 24: The path for this occultation will extend across North America from coast to coast and is bound to cross areas with many observers. Major efforts are planned, with the one by IOTA coordinated by Paul Maley and me. The Sunday evening time will help traveling for the event. Observers in cities near the predicted path will be urged to set up fences of observers at sites extending north and south of their city to provide comprehensive coverage over a substantial range, and not just across the expected primary occultation path based on last-minute astrometry. The AIRN radio network was established mainly in response to this very favorable event, to coordinate the fences of observers set up from various cities. As for other asteroid occultations, all observers should practice locating the star several nights before the occultation; light from the highly gibbous Moon will hinder star field identification, and will pose problems for astrometry a few days before the event.

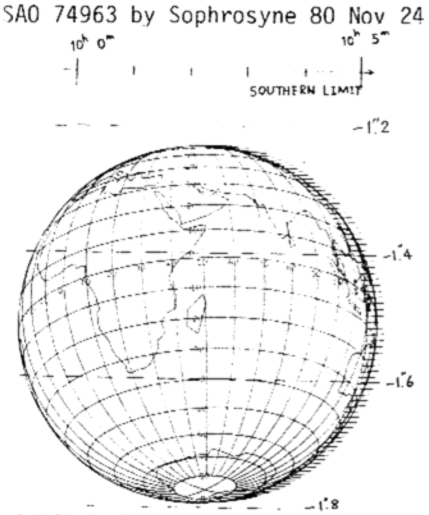
Neptune and SAO 185377, 1980 November 24: In spite

SAO 128184 by Kleopatra 80 Nov 21

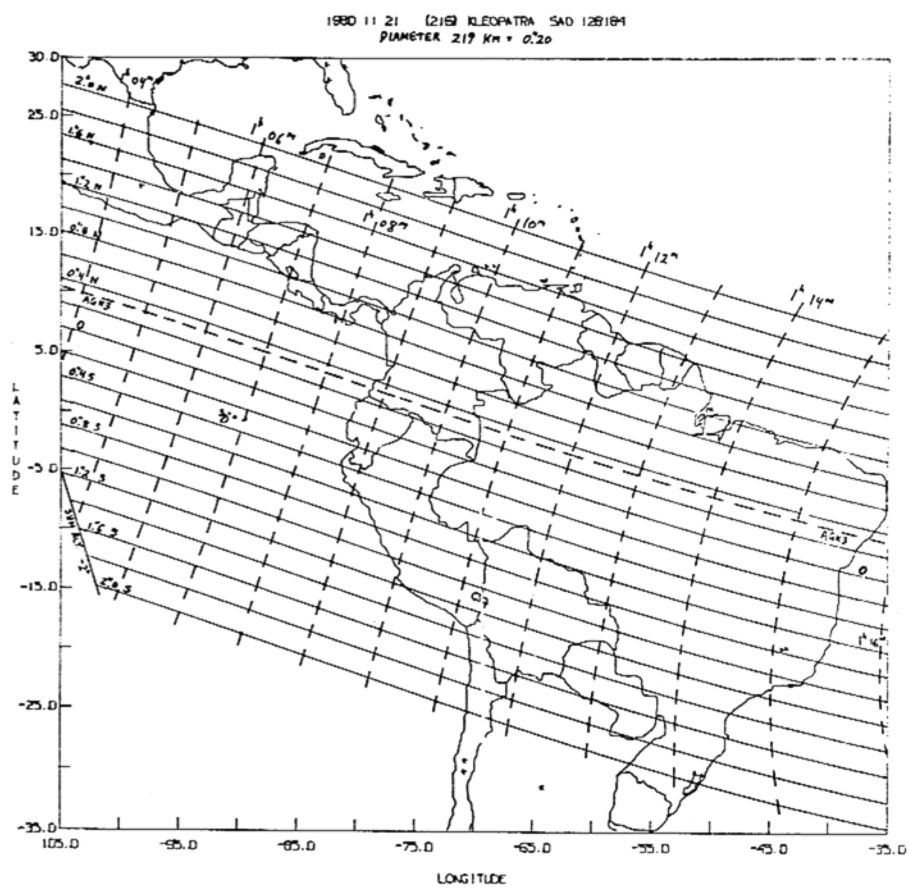




SAO 74963 by Sophrosyne 80 Nov 24



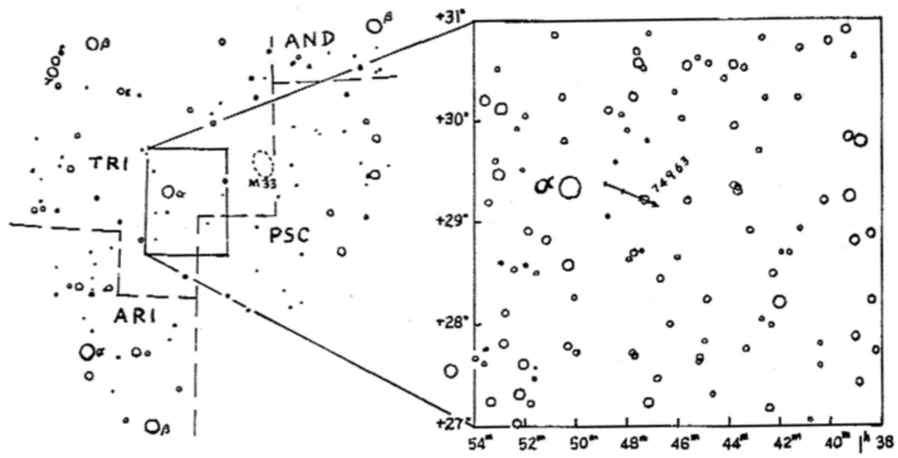
SAO 185377 by Neptune 1980 Nov 24



of the small elongation, there has been some professional interest in this event, due to the brightness of the star and the possibility of detecting rings. By observing photoelectrically in an infrared methane absorption band, it might marginally be possible to monitor part of the event in a narrow area of longitude, but even there, strong twilight and low altitude will prevent useful visual observations. The prediction has been complicated by the poorness of Neptune's standard ephemeris, but empirical corrections were applied by Taylor and me to compute our predictions for the event. Recently I recomputed the predictions using an improved Neptune ephemeris from USNO, and Jim Elliot's group at M.I.T. had done the same thing using a plate taken by Klemola early in the year. We both confirmed Taylor's and my early predictions, showing that central Indonesia and eastern or central Australia are the optimum areas. Klemola plans to take another plate in August for making a final prediction.

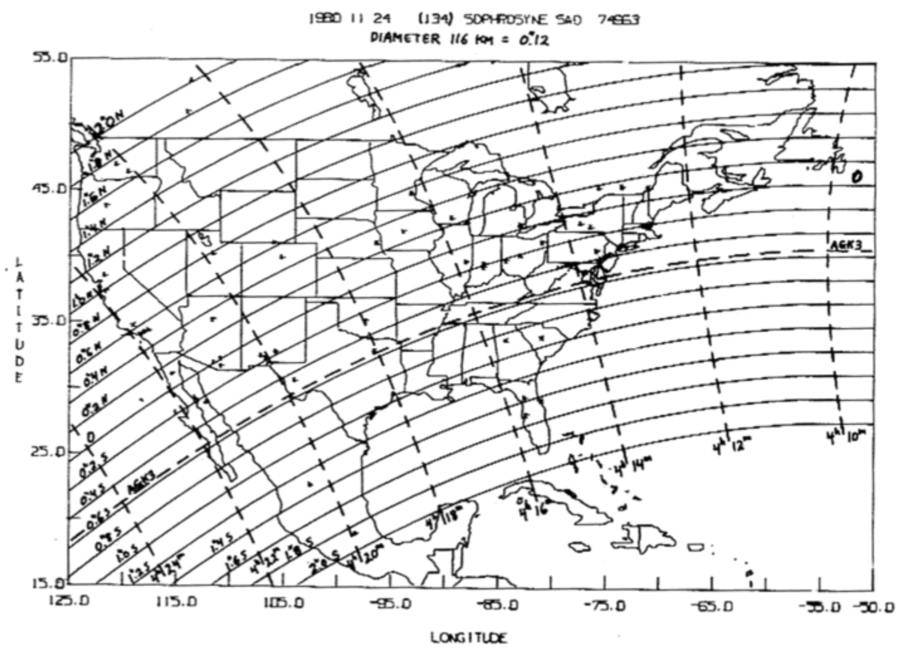
(2) Pallas and 1 Vulpeculae (SAO 87010), 1983 May 29: The path for this event is quite uncertain due to uncertainties in the star's position for 1983 as computed from different catalogs. These range from the northern U.S.A., New England to Oregon, for the AGK3 to a path over south Texas and north Mexico for the SAO (G.C.). An accurate relatively recent observation for the S.R.S. program favors a southern path. The AGK3's astrographic quality is optimized around 8th and 9th magnitude. The AGK3 data for stars as bright as 1 Vulpeculae is generally poor.

SAO 94167 by Eugenia 1980 Nov 28



1980 NOVEMBER 24 SAO 74963 BY (134) SOPHROSYNE H. DaBoll

SAO 139356 by Laetitia 1980 Dec 5

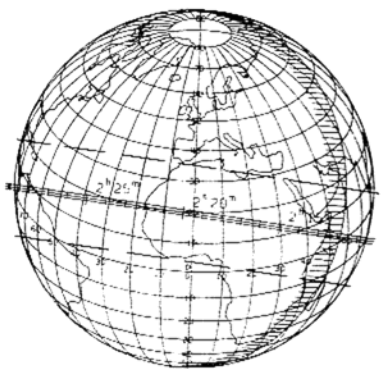


SAO 158606 by Euterpe 1980 Dec 12

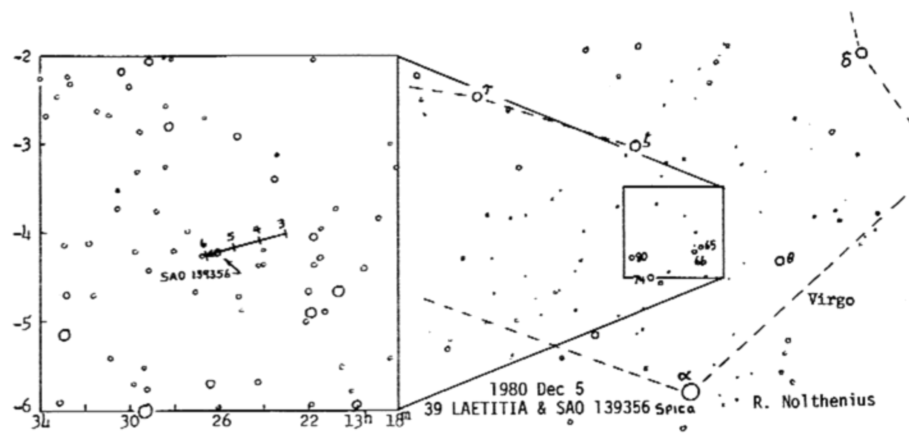
The world maps were produced by Mitsuru Sôma. The regional maps were produced by David Dunham. Names of the producers of the finder charts generally will be found on the individual charts; if no name is found, the chart was produced by David Dunham.

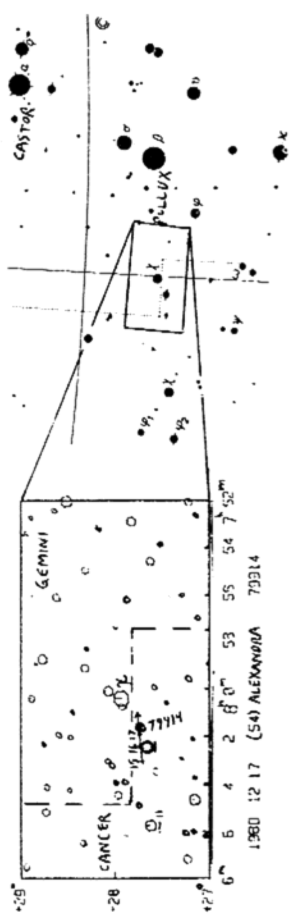
ASTEROID OCCULTATION UPDATES ON WWV

We received a positive response to our initial inquiries about broadcasting last-minute astrometric updates on WWV. The details are now being worked out in conjunction with other members of I.A.U. Commission 20's working group on predictions of occultations by satellites and minor planets. We are proposing that messages be broadcast during the first available minute after 3 hours, 4 hours, and 5 hours U.T. of the night before the night of an important asteroid occultation, and perhaps also two nights before the occultation night. The messages are limited to a length of 42 seconds. The National Bureau of Standards prefers that we limit the number of broadcast messages, but for 1980, we hope to have messages at least for the (78) Diana event on Sept. 4 and (134) Sophrosyne on Nov. 24; there may be messages for Oct. 10, Oct. 26 (for Victoria), and Nov. 21st as well. There will be no messages if no suitable astrometry is obtained, or if the path shifts into areas with few or no observers. We plan to transmit messages to WWV from the National Space Science Data Center at Goddard Space Flight Center under Wayne Warren's direction, after a consensus is reached by members of the working group involved with the last-minute prediction. Messages are mainly for the benefit of those with portable telescopes. But others, especially those near, but not in, the expected path (e.g., within 20 asteroid diameters), are encouraged to watch for the the possibility of secondary events or for possible astrometric error. No message does not mean you should not observe.



SAO 79914 by Alexandra 1980 Dec 17





1980 12 5 (39) LAETITIA SAO 139356

DIAMETER 163 KM = 0".06